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WPI Utilities Usage

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WPI Utilities Usage

An Interactive Qualifying Project Report submitted to the Faculty of Worcester Polytechnic Institute in partial fulfillment of the Degree of Bachelor of Science

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Submitted To:

Faculty Advisor: Michael Ciaraldi

Facilities Advisor: William Grudzinski Sr.

Date: *March 12th, 2010*

Abstract

The Department of Facilities, previously known as Plant Services, at Worcester Polytechnic Institute (WPI) is in charge of a variety of services that at are vital to running campus. One of the important things that the Department of Facilities covers is utility usage and billing among most WPI-owned properties, both on and off campus. The research goal of this project was to analyze the current system of how WPI handles its utilities, namely gas and electric, and propose ways in which the system could be improved and ultimately save the campus money. Through examining the current system, a need was discovered for better organization of bills and meters, as well as for the individual monitoring of on-campus buildings. By talking with WPI staff members and examining how other colleges handle their utilities, a list of recommendations were compiled, and if implemented, would help to not only save the campus money and be better organized but improve WPI's level of sustainability and raise awareness to its community.

Acknowledgements

The project team would like to acknowledge the immense support from their advisors, Mike Ciaraldi and Bill Grudzinski Sr., for all of the helpful advice and guidance over the past three terms. Special thanks also go out to Roy Cordy and Dave Schmidt for providing valuable insight on how the system at Clark University manages their utilities. The project group would also like to thank all of the members of the Office of Facilities who have helped with the project, particularly Marylou Horanzy, Chris Salter, Frank Horanzy, Norman Hutchins, and Mike Lane.

Contents

Abstract i
Acknowledgements ii
List of Figures vi
List of Tables vi
Executive Summary vii
Authorship ix
Introduction 1
Background 3
Overview of Utilities Systems 3
Electric 3
Gas 4
Current Meter and Billing System 4
Methodology 6
Utility Billing and Creating a History 6
Utility Bills 6
Data Entry and Database Solutions 10
Meetings with Utilities Representatives 11
Meetings with Universities (Clark) 13
Meter Observations 16
Building a Meter Map 17
Lucid Design Group Interview 19
Sustainability Projects Interviews 21
Frank Horanzy – Lighting and Heating 21
Chris Salter & Norman Hutchins – Sustainability Projects and E-Mon D-Mon Meters 23
Results and Analysis 27
Meter Monitoring Costs 27
Clark System 27
Building Dashboard 27
Uses of Building Dashboard Gadgets 28
Residence Hall Competitions 31
Clark University 31
Hamilton College 34
Worcester Polytechnic Institute 35
Cost-Benefit Analysis 37

Conclusions & Recommendations 39
Billing 39
Metering 42
Monitoring 44
Future Work 49
IQP 49
MQP 52
Office of Facilities 54
Computing and Communications Center 55
Network Operations 56
Appendices I
Appendix A: Project Overviews I
Initial Overview I
Revised Overview I
A-Term Summary II
B-Term Summary IV
Revised Overview (C-Term) VI
C-Term Summary IX
Appendix B: Weekly Reports XI
August 11, 2009 XI
September 13, 2009 XII
September 14, 2009 (Meeting Notes) XIII
September 21, 2009 XIII
September 27, 2009 XIV
October 4, 2009 XVII
October 12, 2009 XIX
November 2, 2009 XXII
November 9, 2009 XXV
November 16, 2009 XXVII
November 23, 2009 XXIX
November 30, 2009 XXXI
December 7, 2009 XXXII
December 14, 2009 XXXIV
January 21, 2010 XXXV
January 28, 2010 XXXVII

February 4, 2010 XXXIX
February 11, 2010 XLI
February 17, 2010 XLIII
March 4, 2010 XLV
Appendix C: Roy Cordy Visits XLVI
Preliminary Meeting Notes,(9/25/2009) XLVI
Questions to Ask Roy Cordy About Monitoring Systems XLVI
Roy Cordy Interview Transcript (11/17/2009) XLVIII
Appendix D: Letters to Representatives LV
Company Representatives LV
University Representatives LV
Appendix E: Meter Table LVI
Appendix F: List of Buildings on Primary Electric Meter XCIX
Appendix G: List of Off Campus Housing Owned by WPI C
Appendix H: Street Addresses of Owned WPI Property CI
Appendix I: Sustainability Questions CII
Frank Horanzy – Electricity and Sustainability on WPI CII
Chris Salter – E-Mon D-Mon Meters CII
Liz Tomaszewski– Recyclemania and Green Team CII
Norman Hutchins from HVAC – Air Conditioning, Heating, and Timing CIII
Appendix J: Frank Horanzy Meeting Notes CIV
Appendix K: Chris Salter + Norman Hutchins Meeting Notes CVI
Appendix L: Lucid Design Group CVIII
Questions for Conference Call CVIII
Conference Call Notes CVIII
Appendix M: Sample Bills CX
Gas Bill CX
Electric Bills CXI
Appendix N: Main Electrical Distribution Map CXVIII
Appendix O: Meter Walk Around Problems CXIX
Appendix P: Proposed Meter Map CXX
Mock Meter Map CXX
Campus Map CXXI
Proposed Map CXXII
Appendix Q: Relevant Company E-Mails CXXIV

Mike Thompson, National Grid Representative, Meter/Bill Questions CXXIV
James Cleary, National Grid Lead Senior Engineer, Co-Generation CXXV
Appendix R: Clark University Pamphlet CXXVIII
Appendix S: E-Mon D-Mon Data Sheet CXL
Appendix T: Marylou's Billing Spreadsheet CXLII
Example of Electric, Financial Year 2009 CXLII
Example of Gas, Financial Year 2009 CXLIII
Appendix U: Project Team Data Entry CXLIV
Appendix V: Presentation to Facilities CXLV

List of Figures

Figure 1. An Entity-Relationship diagram of a possible database design 11
Figure 2. The elusive Founders Hall electricity meter 16
Figure 3. Main page of proposed meter map 18
Figure 4. Example of Building Dashboard used at Hamilton College 20
Figure 5. E-Mon D-Mon Interval Data Recorder 26
Figure 6. Shuttle Tracking through Building Dashboard at Harvard University 31
Figure 7. Clark University, Residence Hall Competition 32
Figure 8. Pasha, the TellEmotion bear 34
Figure 9. Competition Tab of Hamilton College 35
Figure 10. Overview of WPI CXX
Figure 11. Electricity meter for Stoddard Complex CXX

List of Tables

Table 1. Cost of Clark System 27
Table 2. Estimated Costs of Building Dashboard System 28
Table 3. WPI Residence Halls 36

Executive Summary

Managing utilities efficiently is a very important aspect of becoming more sustainable, as the world as a whole begins to shift toward cleaner, more efficient, renewable energy. The focus of this project is to analyze the utilities at WPI, specifically electricity and natural gas, and make recommendations as to how WPI can save more money and more efficiently manage their utilities usage. A major part of this project was gathering information on all electric and gas meters on campus, and put pictures of the meters with their information onto a map online; to be accessible to the Facilities Department, allowing them to easily locate any meter WPI owns which may need to be serviced. Locating each and every meter on campus, with the help of Facilities advisor William Grudzinski Sr., also gave the group a good opportunity to point out any discrepancies which may have existed between the actual meter number, location, etc. and that which was given on the bill. Another aspect of this project consisted of how WPI could more efficiently monitor their utilities usage in order to make any changes in order to ensure that no utilities are being wasted. However, under the current setup, the Facilities Department cannot monitor the electricity usage of most buildings on campus, due to the fact that they are all fed from one main meter located in the Power House. One solution the group looked at was implementing a system similar to that of Clark University's, where every building is monitored separately and that data is then recorded. WPI has taken steps towards achieving this goal with the installation of pulse meters on a few campus buildings. Another solution the group looked at to solving this was by employing a company called Lucid Design to setup meters for individual buildings in order to see specifically what that building is using. Lucid Design also has a software package called Building Dashboard which allows different users to interactively view the utilities usage of different buildings across campus. The software also allows users to make comparisons between different times of the year, different buildings etc. All of these things will prove to be a valuable resource to WPI as they look ahead to being a leader in the sustainability movement.

At the conclusion of the project the group came up with a list of recommendations for the Facilities Department at WPI; metering of main campus buildings with individual pulse meters is a good way to determine where "holes" in utilities usage are occurring and what can be done to remedy the situation. It was also suggested that the Facilities Department and Department of Finance and Operations at WPI look closer into the economic feasibility of implementing Lucid Design's Building Dashboard on some or even all of the main campus buildings.

Authorship

The project team worked diligently over three terms to split work up as much as possible in a way to produce the best results. The group together attended meetings, interviewed various individuals, and worked on locating and examining every gas and electric meter on campus. William Grudzinski did a majority of the work on the HTML meter map, and Stephen Tetreault worked heavily on entering bills as well as helping Will with organizing the information that went into the map. Mark Hawthorne worked primarily on keeping the group in order through e-mails, meeting requests, and weekly agendas. Mark also did a majority of the work on formatting the report, as well as organizing the SharePoint website.

Section…… ……..Primary Authors

- ***Introduction…***……Tetreault
- ***Background***……
  - *Overview of Utilities System*……
    - Electric……..Tetreault
    - Gas……..Tetreault
  - *Current Meter and Billing System*……Hawthorne
- ***Methodology***……
  - *Utility Billing and Creating a History*……
    - Utility Bills……..Hawthorne
    - Data Entry and Database Solutions……Hawthorne
  - *Meetings with Utilities Representatives.*……Grudzinski
  - *Meetings with Universities (Clark)*……..Grudzinski
  - *Meter Observations.*……Tetreault
  - *Building a Meter Map*……Grudzinski
  - *Lucid Design Group Interview*……Tetreault
  - *Sustainability Projects Interviews*……
    - Frank Horanzy – Lighting and Heating……Hawthorne
    - Chris Salter & Norman Hutchins – Sustainability Project……Hawthorne
- ***Results and Analysis…***……
  - *Meter Monitoring Costs*……Hawthorne
  - *Clark System*……Hawthorne
  - *Building Dashboard*……Hawthorne
  - *Uses of Building Dashboard Gadgets*……Hawthorne
  - *Residence Hall Competitions*……
    - Clark University……Hawthorne
    - Hamilton College……Hawthorne, Tetreault
    - Worcester Polytechnic Institute……Hawthorne
  - *Cost-Benefit Analysis*……Hawthorne
- ***Conclusions & Recommendations…***……
  - *Billing*……Hawthorne
  - *Metering*……Hawthorne
  - *Monitoring*……Hawthorne
- ***Future Work…***……
  - *IQP*……Hawthorne
  - *MQP*……Hawthorne
  - *Office of Facilities*……Hawthorne
  - *Computing and Communications Center*……Grudzinski
  - *Network Operations*……Grudzinski

Introduction

One of the main tasks of the Worcester Polytechnic's Office of Facilities is to manage utilities usage and pay the bills for all of WPI's on and off campus apartments. When the project first started, the group's main goal was to collect all past data on utilities usage, obtainable only from previous bills, and put it into a database, accessible to students as well as staff at WPI to make their own analyses on utilities usage. However, it soon became evident that the feasibility of this was very low, as only utilities bills from the past couple of years could be easily accessible. Many discrepancies between meters' descriptions on the bills and the actual meters also arose, further complicating any efforts to locate bills for specific meters in the past. The group then realized that much work could be done in streamlining the whole utilities usage process. With the help of Chief Engineer William Grudzinski Sr., the group walked around campus as well as the surrounding areas to locate all of WPI's natural gas and electric meters.

The group first looked towards Clark University as a starting point as to how WPI's utilities should be managed. Clark University meters each one of their buildings separately and records usage data to be analyzed. However the system in place at Clark University is not intended for public use, it is only offered as a tool for the Facilities Department in keeping up with their utilities usage.

As a possible upgrade to the monitoring system at Clark University, the group looked into a metering solution which provides real-time usage data, available online to the public, known as Building Dashboard, created by Lucid Design Group. Besides real-time usage, this software allows the user to make comparisons between different buildings, time periods, etc. However this system is a bit more expensive than the system underway at Clark University and its economic feasibility would have to be analyzed more closely by the Finance and Operations Department to determine whether or not it is worth the large investment.

The following report will delve into much greater detail about the problems facing large corporations and institutions, as sustainability and clean energy are increasingly becoming more and

more important in today's society. There will also be descriptions of the methods undertaken by the project group to accomplish their goals. Finally there will be a list of recommendations to the Office of Facilities at WPI on how they can more efficiently pay their utilities bills and meter their buildings.

Background

Overview of Utilities Systems

WPI has four main utilities delivered to its campus; they are electricity, natural gas, water, and sewer. The group decided to focus on electricity and natural gas for the sake of time and feasibility. They decided to ignore water and sewer due the fact that much more money is spent on natural gas and electricity and therefore the opportunity to save is much greater with those two utilities. There are also many more ways to cut down on electricity and gas usage then there are for water and sewer, also providing more savings for WPI.

Electric

WPI's electricity is delivered to the campus from National Grid's substation located on Faraday Street in Worcester, MA. The main meter for the campus is located in the Power House, and this meter feeds most of the academic and administrative buildings owned by WPI, especially on the main campus. Besides the academic and administrative buildings, WPI also owns numerous residential buildings and a few off-campus buildings which are fed through their own individual meters. These meters are separated into four main account types. There are G-1's, G-2's, and G-3's which are all commercial accounts, and then R-1's which are residential accounts. In most cases, electricity is supplied and delivered to WPI through National Grid, however for the larger commercial accounts (G-3's), the actual commodity is auctioned off to the cheapest supplier, however WPI still pays National Grid for the transportation of the commodity, despite the fact that it was supplied from another company. WPI also owns property on Prescott Street such as Mass Academy and the Gateway Building, each of which have their own meter.

Recently WPI has implemented plans to consolidate their bills in an attempt to streamline the bill-paying process and prevent any late-payment fees. For example, the Fuller-Ellsworth Apartments used to all have their own individual meters to keep track of electricity usage, now instead of having forty-two meters to keep track of, there are now only two meters which take care of the entire apartment complex.

Gas

Unlike the electricity utility delivered to WPI, where most buildings on campus are fed from one main meter located in the power house, most buildings which use natural gas have their own individual meter. Like electricity some of the larger accounts are auctioned off to the lowest bidder, usually either NSTAR or Hess Energy, in order to provide the maximum amount of savings to WPI.

Current Meter and Billing System

Depending on the utility, usually more than one bill is sent to Worcester Polytechnic Institute for each billing period. A billing period typically consists of a month, usually starting in the middle of one month and ending in the middle of another. For example, electric bills for apartment 1 at 16 Einhorn Road during the month of August 2009 were based on readings from July 21st to August 18th. The billing periods vary slightly for each utility, but usually the starting and ending dates for a group of bills from the same utility will be within a few days of each other. These variances in billing periods usually correlate to what type of account the meter is, such as the G1, G2, G3 and R1 accounts seen with the electric utility.

For each billing period, every individual electric and gas meter get their own bills, while water and sewer are typically sent together. For electric and gas, every meter has its own unique meter number as well as an account number. The bills are tied to these specific accounts, and are all addressed and mailed to WPI individually. The addresses on each bill vary slightly, and usually include what location on-campus that the bill is for. Many of these addresses are outdated and inaccurate, as they include names of former employees as well as WPI Plant Services, which is now known as the WPI Office of Facilities. The location of the WPI Office of Facilities has changed several times as well, even once within the duration of this project. Previously they were primarily located at 27 Hackfeld Road, and had offices scattered around campus in other locations such as Daniels Hall basement. In January 2010, the WPI Office of Facilities was officially relocated to the former Lee Street Elementary School, which is located at the corner of Institute Road and Lee Street. There are plans to move integrate all of the trades shops from other locations into the new 37 Lee Street facility during the summer of 2010.

Eventually, these bills make their way to Marylou Horanzy, Financial Resource Coordinator at the WPI Office of Facilities. She takes each individual bill and records the total amount of utility used for the given location as well as the total cost into a spreadsheet in Microsoft Excel. Each bill contains a varying amount of sub charges, for things such as going into peak voltage and delivery costs, but only the total sums are recorded by the Office of Facilities. From there, the totals from each utility are added up, and the overall cost for each utility is sent to William Grudzinki Sr, chief engineer of the Power Plant. He looks over the bills for any inconsistencies or wrongly attributed charges, and from there the bills are paid by WPI. The due date for the bills is about two weeks from the ending date of the billing period. The bills are paid using a purchase card[1] that has money set aside for utilities. The typical cost for electricity every month ranges from $200,000 in summer months to nearly $300,000 in winter months. The typical cost for gas every month ranges from $65,000 in summer months to around $150,000 in winter months.[2] From there, the bills are stored in a variety of different physical and electronic locations, and the WPI Office of Accounting gets a copy of the bills and payment receipts for their records.

In terms of meter management, the electric and gas companies send representatives around to measure the current values of the meters for every billing period. Not every single meter is actually checked however, as many are estimated depending on their locations. The Office of Facilities has several spreadsheets with which meters they are responsible for, including their account numbers and what building it's measuring. Currently, the WPI Office of Facilities has no actual way to reliably check its own meters remotely without physically checking the meter. In addition to this, the WPI Office of Facilities also does not routinely send anyone around to double check these individual meters to verify that the utility companies are reporting accurate numbers.

[1] Also known as P-Cards, essentially a corporate credit card
[2] Marylou Horanzy's financial records for the 2009 financial year. Appendix T has examples of her spreadsheets.

Methodology

Utility Billing and Creating a History

The starting point of the project was to learn more about how the billing system for utilities worked, and how it could be improved. In fact, the original scope of the project was to look into constructing a database to house previous bill information so that a utility usage history could be built up and maintained. Once the project team looked into billing and learned more about how utilities are handled at WPI, they found a slew of other issues that really needed to be rectified before a bill database could be properly implemented. This of course not only expanded the scope of the project, but raised the importance of learning about how utility billing worked.

Utility Bills

The project team first worked with William Grudzinski Sr, Chief Engineer as well as co-advisor to the project, to talk about bills and what the Office of Facilities was looking to do. The main thing that was discussed is that the Office of Facilities has no sort of history of their utilities usage, and would benefit from having one in a variety of ways. Basically, when it comes to utilities, the main priority of the campus is to pay the bills as they come in and nothing else. This of course leads to questions such as is the campus overpaying for their utilities, what can be done to reduce costs, is the campus being accurately charged, is there a better company, and many more of the like. When it comes to larger accounts, especially the G3's for electricity, having an actual history of utilities usages and costs is extremely important for getting the best price from companies during the bidding process. With a history, these questions could be answered and the Office of Facilities would have a stronger chance of getting better prices during the bidding process, which would have the chance to save hundreds of thousands of dollars for WPI. The project team was shown several examples of bills[3], and decided to learn more about the system while tracking down what bills WPI currently had in its possession.

[3] Examples of electric and gas bills located in Appendix M.

By examining the bills, primarily electric bills from National Grid and gas bills from NSTAR, many questions were raised. The project group got some of these questions answered by William Grudzinski Sr, who then directed the group towards Clark University's "energy guru", Roy Cordy. On September 25th, 2009[4] the group met with chief engineer Roy Cordy, who explained more about the bills and how Clark University manages their utilities usage. From the meeting it was clear that multiple fields from the bills would be important to record, not just solely the price per unit and the total cost. These other fields covered areas such as peak voltage, delivery fees, and therm factors. The project team also got a lot of ideas from this meeting, and was particularly impressed with how Clark University has their electricity monitoring set-up. Basically Roy is able to see all his electricity meters on campus in real time, and can also see what National Grid's meters are reading. This allows him to take daily readings and slowly build up a very comprehensive history of electricity usage. Roy also discussed how he compared his readings to those of National Grid's meters, and looked into any severe discrepancies between the readings. The project team left Clark University knowing enough about the bills to try some data entry on their own, and decided that another meeting with Roy Cordy would be necessary to learn more about the monitoring system.

After learning more about what values on the electricity and gas bills would be essential to keep track of, the project team began to sift through old bills and perform some data entry of their own. The group started with the most recent bills, those being from the mid-August 2009 to mid-September 2009, and built a spreadsheet for each billing month. As more bills were entered in later on, the team changed the format to each building having its own spreadsheet, so that trends could be seen more easily over time. These spreadsheets were created with Microsoft Excel[5], with the intention being easier to import into a Microsoft Access database if the opportunity arose. After entering the current month of bills, the

[4] Notes from this interview located in Appendix C
[5] Examples of the spreadsheets that the project team used are located in Appendix U

team scheduled a meeting with Marylou Horanzy, financial resource coordinator, in order to find more bills and learn more about the billing system.

On October 5th, 2009, the team met with Marylou Horanzy for the first time regarding the project. Marylou had been working as financial resource coordinator since the summer of 2008, and had been inputting the monthly utilities bills into a spreadsheet similar to the one the project team had attempted. The main difference is that she was only recording the account number of the meter, the utility, the units used, and the total price. For each utility and billing year, Marylou had a spreadsheet with the information of each meter for each month. A billing year at WPI goes from July 1 of any given year to July 1 of the next. For example, the current billing year goes from July 1st, 2009 to July 1st, 2010. The project team also learned that the Office of Facilities only had a limited amount of bills, primarily from 2006 through 2008, and that the bills go to Accounting after Marylou enters and gets the bills ready to be paid for. Since Marylou had recently assumed the position of Financial Resource Coordinator, many of the current bills had mislabeled addresses to outdated representatives or renamed buildings. The project team brought this to her attention, and she said that she had been looking into it with the utility company representatives.

The next step for the project team was to look into finding older bills and entering in the data. The project team contacted the utility representatives to see if it was possible to obtain old records. The best that NSTAR and National Grid could provide were the bills located at their respective company websites. For NSTAR one could log in with strictly one username and password, and see bills and records for the different accounts. For National Grid, in order to see the bills for any given meter, you must log in with its respective account. These processes, especially those of National Grid's website, were very tedious to extract the bill information from. The project team learned about the process of "screen scraping", which is a method of scanning websites or documents and extracting values from them. The problems that the team found with screen scraping is that proprietary software to do it swiftly is quite expensive to come

across, and that it would be too difficult to implement, especially with different bills having fields in various locations depending on the given year. Another problem with the NSTAR and National Grid websites is that they only had bills from 2006 through 2010, which the project team had already tracked down.

The project team got in contact with Charlene Bellows, , Director of Accounting & Financial Reporting, and asked about the whereabouts of old bills and if it were possible to have access to them. Charlene recommended the group investigate ImageSilo, something that the Office of Facilities had access to. This resulted in another meeting with Marylou Horanzy, who explained to the project team how ImageSilo worked and what it was used for. ImageSilo is essentially a document collection website used by WPI to store bills and other assorted items. The project team found some older bills on ImageSilo, but like the other systems, the utility bills only went back to 2006. Also, the project team found ImageSilo to have a clunky interface, and the bills were not organized well. For example, some of the bills were missing pages, which Marylou attributed to a workstudy[6] over the summer. Also, many bills were lumped together in single files, so it was very hard to figure out if you had duplicates of the same bills through the system.

After investigating ImageSilo, the project team communicated with Charlene Bellows once more, this time using William Grudzinski Sr. as the contact. From what the project team understood, many groups have come before to ask for utilities usage information, and the Office of Accounting simply did not have the resources to distribute out the bills. Charlene explained was that Accounting kept up to seven years of bills, which would date their current records between 2000 and 2003, and kept them stored in the basement of Boynton Hall and other locations. The final word from Accounting was that they could not find the old utilities bills, and that they were likely lost within the archives or moved somewhere off-campus. Also, older bills that were not stored on ImageSilo may have been recorded on microfiche. The

[6] A workstudy is essentially a student employee

problem with releasing these copies to the project team, and even William Grudzinski Sr., is that they contain sensitive information about WPI's financial accounts.

Data Entry and Database Solutions

While the project team was learning about the billing system and tracking down old bills, they spent the first few weeks of the project learning about different database solutions that could be used to store information about bills. The team met with Bryan Ferguson, an administrator of the Computer and Communications Center, to discuss the possibility of hosting a database with school server space. Bryan strongly recommended that the project team would look at database solutions supported by corporate software, as internally built projects would be a disaster in the future. The problem with building something like a SQL database, and creating a specific interface for it, is determining who in the future would be able to maintain it and fix it should things break. Bryan said that there have been many instances in the past of pet projects that simply break and become useless once the students involved have graduated from WPI since no one is there to support it, and nobody else on campus knows how to maintain and fix it.

In A-Term of 2009, both Mark and Will took courses in database systems. Both got some experience in SQL and using Microsoft Access, and Mark did his final project simulating a utility database. What the conclusion that both of them came to was that SQL is very easy to learn, but is very tedious when it comes to making statements for all the different possible types of queries. What Mark learned in his project is that the graphical interface when working with something such as pure SQL is very tedious, and would be very difficult to update and maintain in the future. Regardless, the project team took some valuable lessons from this, and used the experience to model their utilities database using an entity-relationship schema. The project team decided it would be ideal to examine corporate software for building and updating databases, such that they could be maintained easily with corporate support in the future. Currently, WPI owns licensing and support for several database solutions, primarily Maximo and Microsoft Access. The project team explored Microsoft Access a bit more, and learned that data could be

easily imported from Microsoft Excel spreadsheets. Since spreadsheets were already used to enter in data, as well used by Marylou Horanzy, the project team continued to do its work in Excel since it could be used for an Access database.

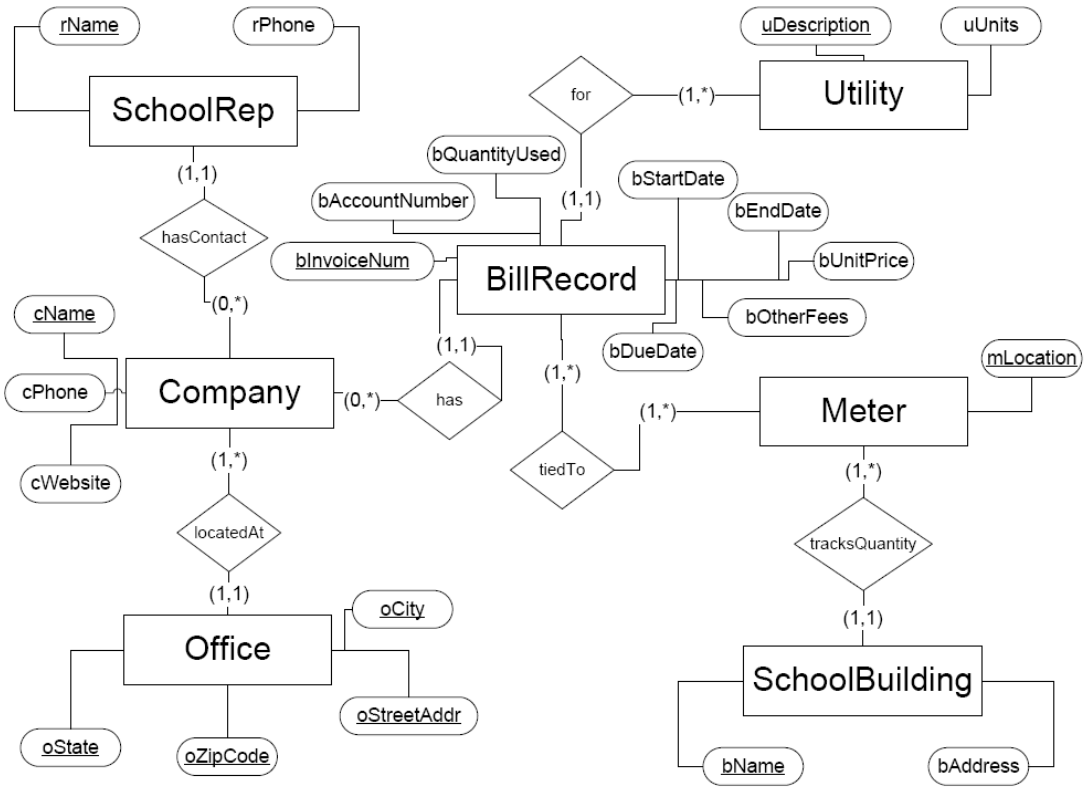

Figure 1. An Entity-Relationship diagram of a possible database design

Meetings with Utilities Representatives

WPI has two main suppliers of utilities for the main campus and the adjacent WPI-owned properties. All electric service to WPI is delivered by means of National Grid's infrastructure. For some of the larger meters, WPI will bid contracts to third-party vendors for the actual electricity, however, it still must be delivered through National Grid. Therefore, every electric meter for a WPI property incurs a charge from National Grid, whether just for delivery or for both delivery and service. The National Grid representative assigned to WPI is Michael Thompson. The company that supplies much of the natural gas for WPI is NSTAR. Similar to National Grid, NSTAR charges a delivery fee for all the gas meters, regardless

of whether the gas is purchased through them or, as it is done on the larger accounts, through third-party vendors. The NSTAR representative assigned to WPI is Thomas Angelo.

In order to better understand the processes involved with the utilities at WPI, the group contacted both customer service representatives with a few questions[7]. The first question was in regards to reading the meters. The group inquired as to how this was currently being done, and hoped to make recommendations based on the findings. It was discovered that National Grid uses three methods to read their meters. The large service accounts (G3) are read remotely via a phone line. The medium accounts are read manually by a National Grid employee driving to and reading the meter. The smaller accounts (R1) are read using a van equipped with automated meter reading technology (AMR) that is able to wirelessly read the meters as the van drives down the street at moderate speeds. The second question had to do with the observation of usage estimations on a good portion of the utilities bills. This can happen for two reasons: the meter reader is unable to locate the physical meter or the AMR device does not pick up a signal from the meter as the van passes by. When National Grid fails to receive a reading for whatever reason, an estimate is generated based on the trend for that particular meter location and the given time of year. This ensures that something is billed rather than waiting another cycle and billing for two months. If the estimate is incorrect, the difference will be compensated for on the next billing statement. Finally, the group inquired as to where the electricity for the main campus comes from. There is a substation on Faraday Street in Worcester that feeds WPI. However, it feeds several substations that also feed into WPI. This ensures that WPI always has a reliable electricity feed from the grid. The multiple substations utilize load-balancing, however if one were to drop-out the other substations could pick up the slack. This ensures that WPI will experience very little to no power loss. Very often when power is out in the surrounding neighborhoods, WPI is still well lit.

[7] E-mail and response located in Appendix Q

The group contacted Mr. Angelo and asked him the same three questions. NSTAR uses an electronic reading transmitter (ERT) to read most meters wirelessly. This is similar to National Grid's approach. A van is sent around the neighborhoods and as it passes by, it receives a transmission from the meter. The larger meters are read manually by an NSTAR employee. This is because there is not currently an ERT that has been perfected for the larger accounts. These involve more money and larger loads, so the readings must be accurate all the time. The company is working on a solution, however, to implement an electronic reading system for these large meters in the future. If there is a problem with the ERT, or if there is no reading for any other reason, NSTAR will generate an estimated bill in a similar fashion to that of National Grid. Trends and time of year factor into the estimated usage. The natural gas that supplies Worcester County is distributed from NSTAR's "take station" on Upland Street in Worcester. It gets to that point from the Tennessee Pipeline. The group inquired about the use of the Internet to read the meters without the need to send out vans at all. Mr. Angelo informed us that the ERT system has been in place for roughly 20 years and has cost millions of dollars over the years. Therefore, it is highly unlikely the company will overhaul an existing and functional system.

Meetings with Universities (Clark)

Clark University is a private university located in Worcester, Massachusetts. It offers its students a valuable education incorporating liberal arts to "address social imperatives in a global context".[8] Clark University has proven itself a leader in innovation towards becoming a green university, leaving less of a carbon footprint on the environment. A great feature of this is that Clark is also able to save money by using less resources and encouraging its students to conserve energy through competitions and other similar programs.

To learn more about Clark's commitment to sustainability and hopefully learn some tactics that may be useful for WPI, the group set up several meetings with Roy Cordy, the Chief Engineer of the Power Plant at Clark University. He was more than happy to share his knowledge of the industry coming from his

37 years of experience at Clark. The following comes from a meeting between the group and Roy on November 17, 2009. [9]

Clark University generates its own electricity, something that WPI once did but has since discontinued. Clark began the process of cogeneration back in 1982, when it became the "nation's first power-grid-connected demonstration power plant".[10] Cogeneration is the simultaneous process of producing energy in two forms. At Clark, this is done with both electricity and heat being produced from the same pieces of equipment. Clark's cogeneration plant depends heavily on the Fairbanks Morse 9-cylinder turbocharged dual fuel opposed piston engine. Roy informed the group that this engine was originally destined for WPI as a grant from the US Department of Energy, however for reasons unknown to him, WPI turned the offer down. Clark was the second pick, which is where the engine still resides today. The engine is capable of producing about 2500 horsepower and driving a generator rated at 1807 kilowatts. The exhaust gases from the engine are pumped into a Riley Beaird exhaust boiler which then produces steam at 125 pounds of pressure, the same pressure produced by the existing steam plant. This steam is then used for heating the buildings across Clark's campus and for hot water. Back when the cogeneration plant was first installed, being interconnected with the electric grid enabled Clark to sell back whatever it did not need to the power company (Mass Electric). Unfortunately, when the 20 year contract ended in 2002, the power company—now National Grid—informed Clark that they would no longer be able to purchase electricity from the university. This meant that any excess electricity produced and put back into the grid would generate no revenue for Clark. Therefore Clark began producing just under what the actual demand for the campus was, to ensure that they would never be giving away electricity to the power company. Of course, this also meant that Clark began purchasing some electricity from National Grid on a daily basis. This has become less important recently as Clark's campus has

[8] Clark's Website, on the About Section
[9] Full transcript of meeting is located in Appendix C

expanded so rapidly that the old engine is no longer capable of meeting the constant demand for power. Roy informed the group of his interest in obtaining a second engine; however that may not be practical for a while due to costs and the lack of space to house it. When Roy began working at Clark, the demand for electricity was approximately 1200 kilowatts. The current demand now averages 2700-2800 kilowatts, more than double the demand in the time the engine was installed. Clark's current project deals with examining options for new boilers, similar to what WPI did a few years back, in renovating its power plant facility.

Another way Clark is investing in energy and green technology is through the use of its exhaust boiler. This boiler uses the exhaust from the diesel engine to generate steam with which they heat the surrounding buildings. This is highly efficient since Clark is able to harness not only the electric power from burning the fuel, but also the byproduct of heat, in the amount of approximately 57,000 BTUs per day. This amounts to a $30,000-$40,000 savings per month. Roy informed the group that this really does work to the university's advantage, as they stand to both decrease their dependence on fuels such as diesel and decrease their costs on such resources.

Clark University purchases their utilities for larger accounts in a fashion similar to WPI. While the delivery lines are all supplied by either National Grid or NSTAR, the service may be supplied by any third-party vendor. Roy discussed the reason for looking to a third party. The biggest advantage is cost savings. He talked of Clark's past and being one of the first in the area to purchase these commodity utilities. There was an annual savings of about $125,000-$150,000 just by buying commodity instead of the local supplier. The downside to this method of purchasing utilities is that the market fluctuates. Therefore, while one stands to save a decent amount of money, there is also the chance that prices will drop, however, one's organization may still be locked in at a certain—and often higher—price.

[10] Pamphlet located in Appendix R

Meter Observations

One of the biggest tasks towards completing this project was identifying all of the meter locations across campus and verifying that there were no discrepancies and fixing any that did arise. This was accomplished with the help of facilities advisor, William Grudzinski Sr. Over the course of many weeks, the group was able to successfully locate all of the gas and electric meters, verify their meter numbers, and document their location with an HTML map available to the Facilities Department to aid in locating any meters which need to be serviced. This map will be explained in detail further in the report.

While determining the meter locations, the group also successfully pointed out any discrepancies with the meter numbers or their descriptions in the bills.[11] For example, the gas meter outside of Health Services on the corner of Institute Road and Hackfeld Road is against code, due to the fact that it is within a certain distance to an ignition source. Discrepancies about the locations of individual meters were also rectified. For example the electric meter providing service to Founder's Hall is located in the basement in one of Campus Police's back rooms, which no one seemed to realize existed. This would have made it impossible to service the meter if a situation ever arose where the meter was malfunctioning and had to be replaced.

Figure 2. The elusive Founders Hall electricity meter

[11] This list of discrepancies is in Appendix O

Overall, having a complete list of electric and natural gas meters on campus and their descriptions and locations available online will allow the Facilities Department at WPI to much more efficiently inspect any meters which may not be working properly.[12] Having the locations of all meters will also help any discrepancies which may arise due to the fact that servicemen reading the meters each month cannot always find every meter and may need to estimate the usage from time to time. With this system successfully implemented, the serviceman will simply contact the Facilities Department, who will then be able to direct them to the proper location to take the meter reading.

Building a Meter Map

A major focus of this project was the creation and recommendation of the eventual implementation of an interactive campus map, containing utilities information such as electric and gas meters, with the capability to be expanded to include water meters, fire safety, and any other physical plant information. The map changed face several times throughout development, finally resting on the standard campus map image as the base, supplied from Marketing and Communications. This campus map shows all WPI-owned properties on the main campus, as well as academic, administrative, and residential properties off-campus. Also included is the newly added Gateway Park.

Once the main campus map was obtained, the next step was deciding how to break up the campus. The group decided on splitting the map into nine roughly equal quadrants. These were not evenly divided as to minimize the impact of slicing buildings in half. Once this was decided, it was time to being developing the web interface. Will met with James Monaco, Instructional Media Specialist for the Academic Technology Center at WPI, about the possibilities at our disposal. The first option was to use HTML to build the system, and integrate CSS for aesthetic effects and JavaScript for functionality. We opted out of this at first, since it seemed like the most work. James offered as a second option, Adobe Fireworks. Among other things, this program has the functionality necessary to divide images to create

[12] Meter table from the printable full meter list is located in Appendix E

image maps. Image maps are essentially invisible shapes that are "drawn" across the image, using coordinates as points of reference. These shapes can then be used to trigger events, such as links to a new website. This sounded like the most viable option, so the group pursued it. However, the group quickly encountered trouble. The program was not extremely intuitive, lending to confusion and the necessity for training and help. Therefore the group decided to pursue the original method for creating the map system—HTML.

The overall system was designed using a text editor and basic HTML tags. Once this layout was developed, a page was made for every property or building, as well as an index, and the pages for each of the nine quadrants. The content was then added to the already existing pages. The group recognizes that perhaps a Flash application would be a better visual display of the information, however, for the sake of time and the ease of upgradeability HTML was the best fit for this project and its continued use by the Facilities department at WPI. HTML is a fairly simple language to understand, and with the proper documentation and subsequent training of Facilities personnel, the group feels this map will have a long-lasting effect with the potential to be integrated into daily operations of Facilities and Physical Plant staff.[13]

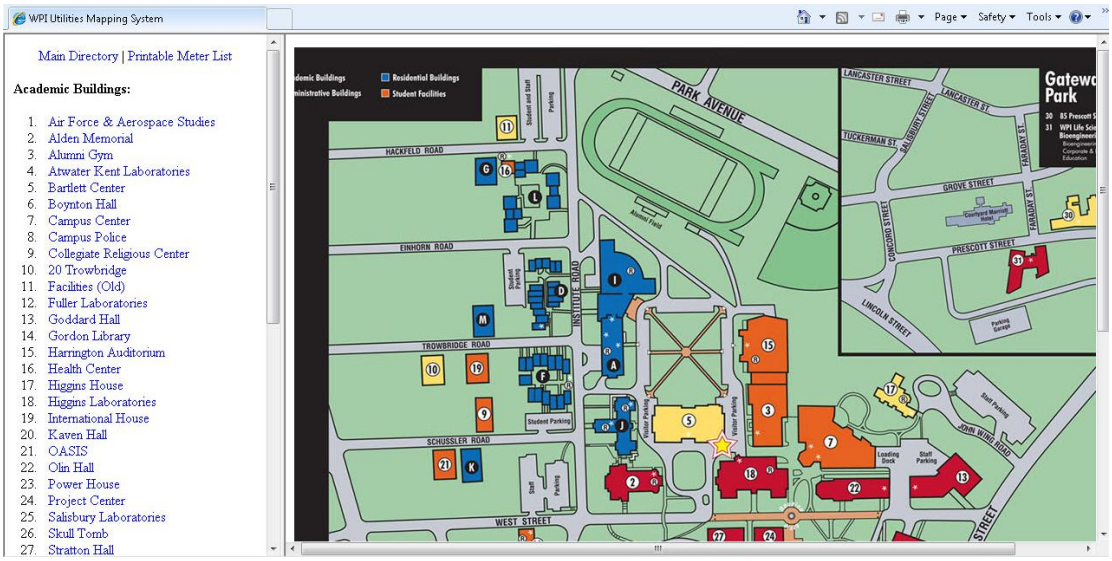

Figure 3. Main page of proposed meter map

[13] More pictures of the map located in Appendix P, Printable meter list information in Appendix E

Lucid Design Group Interview

The group learned about a company, Lucid Design, which specializes in meter monitoring and data analyzing, from an email sent out by Alfredo DiMauro, Assistant VP for Facilities, showcasing a Lucid Building Dashboard in place at Hamilton College[14]. After viewing Hamilton's site, the group looked at the possibility of contacting Lucid Design about setting up a Building Dashboard (the web interface for monitoring utilities usage) for WPI. The first step the group took was contacting Lucid Design about setting up a possible teleconference or web meeting to discuss initial costs and ask questions which would help the group determine whether or not spending the money to set up a Building Dashboard would be cost-efficient.

Building Dashboard is essentially a dynamic web-based system in which to show the utilities usage of various buildings. The system is integrated with current electricity and gas meters which are then connected to the Internet. From there, the data is pipelined and stored on Lucid Design Group's dedicated servers, and nothing is stored at the customer's location. This data is then fed into a webpage, a customer's own Building Dashboard, which has a variety of gadgets and graphs that display the information to the public in very interactive manners. A major advantage to this cloud computing solution is that it is professionally maintained by Lucid Design Group, who will provide various forms of technical support for only $2000 a year after the system has been installed.

As for company background, Lucid Design was formed in 2004 and they currently have over 100 customers and 300 buildings online, mostly consisting of universities but they also have clients from the government as well as some notable corporations. Lucid Design's software, Building Dashboard, allows for real-time monitoring of utilities usage. The software allows the user to choose different "modules" located at the bottom of the main page which do everything from provide the latest electricity usage of buildings on campus to the weather.

[14] http://buildingdashboard.com/clients/hamilton/

The group contacted Kai Mak, a representative from Lucid Design, and set up a teleconference to take place. In the teleconference the group found out a great deal of information from Kai Mak regarding the system.[15] The biggest issue facing whether or not Lucid's Building Dashboard would be a viable option for WPI would be the cost required to implement it. From the meeting the group learned that the most popular choice was the starter kit, which includes two meters for two buildings costing $9995. Over the past winter break the Facilities Department, under direction of Chris Salter, Director of Project Management and Engineering at WPI, installed E-Mon D-Mon pulse meters in select locations across campus. The group was able to determine that these meters are compatible with Lucid Design's software, meaning that WPI would be able to save by using the meters which are already in place instead of having new ones installed. Another important detail the group found out was that buildings could be put online in stages, so funding for all buildings on campus would not be required up front, it also allows the first building or two to be tested as a "trial version" to prevent wasting money if the project is deemed unsuccessful.

Figure 4. Example of Building Dashboard used at Hamilton College

[15] Conference notes in Appendix L

Another point Kai Mak made was that the Building Dashboard software would help contribute to a building's LEED certification. This brings up one of the most important objectives of implementing the Building Dashboard system, and that is to project an image to the public that WPI is actively trying to become more environmentally friendly and reduce its utilities usage. One option for showcasing this image is the option to install a touch screen display, which will provide everything shown in the Building Dashboard, in the main lobby of a LEED certified building (East Hall) to show prospective students and their parents that sustainability is very important to WPI.

After the meeting concluded, it was determined that the group should begin to get in contact with the Facilities Department and possibly Finance and Operations to discuss the economic feasibility of installing the Building Dashboard system, along with a few new meters, for WPI, as the school looks to provide an image as a leader in sustainability.

Sustainability Projects Interviews

After learning more about systems to monitor meters and display the results to the community, the project team wanted to find out what kind of projects WPI had underway to cut down on utilities usage, and if they would benefit from a real-time monitoring system. The group came up with a set of questions for four people – Frank Horanzy, Master Electrician; Liz Tomaszewski, Sustainability Coordinator; Chris Salter, Projects Manager; and Norman Hutchins, Mechanical Operations Super.[16] The project team did not get to meet with Liz due to time constraints, but were able to interview the other three about sustainability projects on campus.

Frank Horanzy – Lighting and Heating

The group decided to interview Frank Horanzy about any projects that have been done or could be done to save money and be greener since he deals with things such as lighting and heating on campus, two very large contributors to energy usage. One of the big things discussed in the interview were how so many lights were left on during the day and even on at night, not only in the residential buildings but

[16] Question list in Appendix I

within the academic buildings themselves.[17] Frank explained that around twelve to fifteen years ago, WPI had funding to set up motion detectors in various classrooms and bathrooms around campus. Some of these can still be seen in Fuller Laboratories, specifically in the bathroom, as well as hallways in Daniels Hall and Morgan Hall. He said that funding for green initiatives like these are few and far in-between, and that it is very hard for the campus justifying spending the money if they will see little in return.

Frank also discussed several cases of faculty and staff members being against the motion sensor lights, preferring a light switch over the energy efficient version. A specific example of this was an office in Higgins Laboratories, and the professor in question had a hat rack that blocked the motion sensor from working properly. Instead of simply moving his hat rack, the professor complained and refused to move his office around so that the sensor could work properly, so Frank had to go in and replace the sensor with a normal light switch. This is even seen today with buildings such as East Hall and Gateway Park, as there was not enough funding to purchase enough motion sensors to properly cover these areas. There are many cases in both of these buildings where there are essentially dead zones where the sensors will not pick up on human motion.

Frank also discussed how many classrooms have no sort of control, and that it's a large endeavor to find a system that not only handles the lighting of a room, but the projection and computer systems which are occasionally left on throughout the evenings and through the weekends. It really comes down the fact that it's nearly impossible for the school to figure out if they are saving money, and that it's hard to rewire some of these buildings to be more green and efficient. Frank believes that to properly do initiatives like these motion sensors, that many of the older buildings would have essentially need their wiring gutted and completely redone, which is an expensive and tedious project.

Other topics that were discussed were replacing the lightbulbs with more efficient bulbs, and Frank discussed the different types such as T12's, T8's, and T5's. Around fifteen years ago, most of the T12

[17] Meeting notes in Appendix J

bulbs on campus were swapped out for T8s which are more efficient and consume less energy. Frank talked about how East Hall uses T5 bulbs, which he feels are less efficient as they burn faster on the ends since they get hotter and do not last as long as the T8's and T12's. The library renovations were also another topic discussed, and Frank said that there are over 200 ballasts within the building, many that need to be replaced by something that is more efficient. Another topic Frank focused on was the heating in the building, and how AC control was recently installed in Salisbury Labs 315 and 402. He says that part of the system is based on time and that part of it is based on motion. The campus generally is between 68 and 69 degrees during the day, with it turning down from 62 to 65 degrees at night. Frank said that Facilities goes on the assumption that the buildings will be occupied for 12 hours on a given day, and are tuned from there as seen fit.

Ultimately, Frank believes that green initiatives are important, but that it is very hard to justify their costs. Frank said that even with a real-time monitoring system, it would be possible to make more tweaks and changes, but it really comes down to the funding that is provided and what the project is aiming to accomplish. Ideally, the new buildings on campus should be designed with these energy saving ideas in mind from the beginning, so that down the road these problems do not arise in the first place.

Chris Salter & Norman Hutchins – Sustainability Projects and E-Mon D-Mon Meters

In the beginning of January 2010, the project team learned that the Office of Facilities had installed some of their own electricity meters during winter break. The group was quite intrigued by this discovery, as currently WPI has no actual electricity or gas meters of their own. Through some e-mails and correspondence with William Grudzinski Sr, it was discovered that Chris Salter and Norman Hutchins were the key players behind the additional meters, and that the meters were from a company called E-Mon D-Mon. The project team explored the company's website, and learned that they make meters and have software that would be similar to the Schneider Electric system used by Clark University. After a few

more e-mails, the project team scheduled a meeting with Chris and Norman, to discuss sustainability projects as well as these recently installed meters.[18]

In the meeting, one of the major topics discussed was air conditioning, and how the need for it has changed over the course of WPI's history. Chris Salter discussed how back in the 1960's, when a lot of the newer academic buildings were being built and planned, that WPI did not have much going on during the summer. This of course meant that air conditioning was not a large priority to be installed in buildings, since no one would be living in the residence halls over the summer and most of the on-campus staff would only be in a few select buildings. Currently, summers at WPI are much busier than in the past as you have classes in E-term, various camps such as Frontiers and Launch where participants live in residence halls, and so much more. In the 1970's and 1980's, the need for air conditioning increased greatly, which can be seen in the renovations to Atwater Kent and Salisbury Labs that took place in that time period. Chris also talked about how window-mounted air conditioning units are all over campus, and he believes that they are very inefficient. The problem is that air conditioning is something that usually gets cut off of building renovations, and the windowed units are a cheaper and quick alternative. Another big example of this is the renovations in Alden Hall in the 1990's, and air conditioning was originally planned but cut out to save a few hundred thousand dollars. The ironic thing is that nearly a decade later, with things such as big campus events and graduation taking place in Alden Hall, that air conditioning was added back in as it had became a necessity in the eyes of many higher-ups on campus. The problem is that retrofits like these occur all over campus, and usually cost at least twice as much as the original proposed costs.

The other large topic discussed in the interview was the E-Mon D-Mon meters that were installed over winter break. Chris and Norman explained that they were placed in Morgan/Daniels Hall, Riley Hall, and Fuller Labs. The one meter that is for Morgan and Daniels is located in Daniels basement. There are

[18] Meeting notes in Appendix K

actually three meters that were installed in Fuller Labs, one to track electric/heating, one to track lighting, and one to track mechanical consumption.[19] Currently none of these meters are fully working, and the one located in Daniels is the closest. Norman said that he is in charge of troubleshooting the meters, and that he is working closely with Network Operations to figure out if there are firewall or connection problems that prevent the Daniels meter from transmitting properly. Chris explained that the need for having discrete monitoring of meters is not a new topic, and that the hardest part the Office of Facilities has with the topic is raising the funds to pay for the system. Apparently the funding for these meters came from rebates and grants for the 2009 fiscal year. However, currently they will not be receiving any additional funding for the project in 2010 and 2011. This makes it hard to expedite the process and spread meters all over campus. Chris estimated the price of the meters and installation to be around 7,000 – 8,000 dollars each, and that it could probably worked down to 5,000-6,000 dollars depending on how it's contracted out.

The project team also discussed methods of displaying information to the campus as a whole, especially with a system such as Building Dashboard by Lucid Design Group. Chris explained that they had looked into several systems in the past, but are afraid of being locked into a contract with a company with shoddy support and high contract fees, such as within the range of 5,000 to 7,000 dollars a year. Ideally, the Office of Facilities should have total control over its monitoring, but then the problem as Chris described, how do you get this information out to the public, and how can you do it in a way that is effective and maintainable in the future. It seemed like the Office of Facilities already has too much to deal with, and that coming up with and maintaining a system is a large feat within itself. Chris and Norman were interested in the brief explanation of the Building Dashboard system, and what it really comes down

[19] Refers to the electrical consumption of air conditioning and HVAC units, which are critical for the server room

to is securing the funding and setting up the support for the future. The type of meters that are being installed from E-Mon Demo are called Interval Data Recorders.[20]

Figure 5. E-Mon D-Mon Interval Data Recorder

[20] Information sheet about the Interval Data Recorders is located in Appendix S

Results and Analysis

Meter Monitoring Costs

Clark System

Through talking with Elio Chimento, Clark University's head electrician, the project team was able to get a rough idea of how much the system cost. This software for the system, as well as the meters, were done through Schneider Electric.

Table 1. Cost of Clark System

Item	Cost
Meters (24 meters, equipment, software)	$62,000
Server (hardware and licensing for 10 users)	$5,800
Labor (using Clark's 6 in-house electricians)	$6,500
TOTAL	**$74,300**

Ideally, implementing Clark's System would work at WPI, as WPI is of a similar size. The main differences are that the labor would most likely be contracted out, and that there may be a desire to have more than 24 buildings be monitored. E-Mon D-Mon is also a partner of Schneider Electric, and has systems similar to those implemented at Clark University.

Building Dashboard

Through communications with Kai Mak, rough estimates of the Building Dashboard system were obtained. These costs should be somewhat cheaper if WPI were already to have meters installed, such as the E-Mon D-Mon meters.

Table 2. Estimated Costs of Building Dashboard System

Item	Cost
Starter Package (Server, 2 meters, 1 year of licensing/services)	$9,995
Yearly Maintenance/Licensing Fee (Trouble shooting, data storage, gadgets)	$2,000
Estimated Costs for 8 buildings (electricity, meters)	$25,000
Extrapolated Costs for 24 buildings (electricity, meters)	$75,000 (mostly likely would be less in bulk amount)
TOTAL	
2 Buildings with 1 Year of Support	$9,995 + $2,000 per year afterwards
10 Buildings with 1 Year of Support	$34,995 + $2,000 per year afterwards
26 Buildings with 1 Year of Support	$84,995 + $2,000 per year afterwards

The cost is similar to that of the Clark University system, with the added bonus of a more effective way of reaching out to the community. Drawbacks for WPI may be increased fees for meters, although the meters through Lucid Design group seem to be a bit cheaper than the E-Mon D-Mon meters that have currently been bought. The project team was given that rough estimate for 8 buildings, so it is likely that the cost would be less than triple the amount for 24 buildings, which is around the number that WPI would aim to fit. Ideally, WPI would meter most of the buildings on its main powerhouse meter, as well as a few of the other large buildings such as Gateway, the new Athletics Center, Founders Hall, and East Hall.

Uses of Building Dashboard Gadgets

The neat thing about the Building Dashboard system is that the Lucid Design Group is willing to make new software applications, called gadgets, for the demands of the customer. Instead of simply

sending out e-mails to all undergraduates, faculty, and staff members, the Office of Facilities could reach out through a dynamic webpage with real-time monitoring of buildings as well as other enticing features. An example of a website used by WPI that is very similar, although used primarily by residential students, is the Laundry View website. By going to www.laundryview.com, WPI residents are able to find out if the closest laundry rooms near them are being occupied, and can essentially watch their laundry wash and dry in real time. The site models the various laundry rooms in 3D, shows which machines are free, which machines are broken, and which machines are in use. For the machines in use, it has a little timer on them, showing how many minutes left in the current cycle. This system is used easily by all residential students on campus, which reaches out to about 1,500 students a year. The neat thing is that even when students move off campus as they become upperclassmen, they still recommend the website to incoming freshmen as the system works extremely well and is such an excellent tool. Ideally, if the Office of Facilities can chose the right medium to present utility usage in, they could easily make it so everyone on campus know about it, from the freshmen to the seniors to the faculty and staff members. The gadgets that Lucid Design Group provide and could possibly create, could be the neat little tools and quirks that attract the WPI community towards using the site, and ideally working to be more sustainable when on campus.

One of the biggest things that the Lucid Design group can provide are touch-screened kiosks, which would work quite effectively in places such as the Bartlett Center, the Campus Center, and the proposed forthcoming athletics center. Imagine having prospective students and their parents walk into the new athletics center, and see a big kiosk in the lobby that shows how much energy the building is using, how much it is saving, along with an assortment of clever gadgets and applications that show how unique WPI is and how strong its sustainability efforts are supported by the WPI community. Kiosks like these would reach out to the alumni and trustees as well, and would give the student population an interactive reminder of the system.

Going back to different gadgets, there are many different ways WPI could theme its Building Dashboard page to reach out to the community. One really neat feature at Harvard University's building dashboard is a shuttle tracker, which shows their campus shuttles moving around Boston in real-time. A gadget like this could be applied to the SNAP vehicles and the Gateway shuttle, and would be something that the student population would find as a useful yet entertaining tool like Laundry View. It is possible to integrate news feed widgets which could advertise green events as well as the events of other student organizations and departments, which would be a good way to reach out to the community. Many organizations will jump on the chance to advertise their events and meetings, and WPI's Building Dashboard could bank on this opportunity to get constant content and support.

Recyclemania is a relatively new competition that the school participates in, but its results are usually strictly related to e-mails. Many students end up ignoring these e-mails, and the project team feels that a gadget could be made for Recyclemania that is just as dynamic as the building readings, with graphs of the different campuses or residence halls and how much they've saved. In fact, a gadget like this could not only draw more people to the Building Dashboard site, but would bolster the effectiveness of the Recyclemania program as well.

The Building Dashboard system would also make it easier to co-sponsor energy saving programs, such as Residence Hall Competitions and "black-out" events, with student organizations as it would be more effective than just e-mails to reach out to the community. Organizations such as Residence Hall Council, Social Committee, Student Government Association, Student Alumni Society, and even fraternities and sororities are all viable options for co-sponsoring such programs. Perhaps they could even pay for the prizes and do a bulk of the advertising, which would take a lot of stress off of the Office of Facilities and would make these events happen more frequently. The Building Dashboard provides lots of options for unique WPI-themed gadgets, and would allow the Office of Facilities to hold stronger green events.

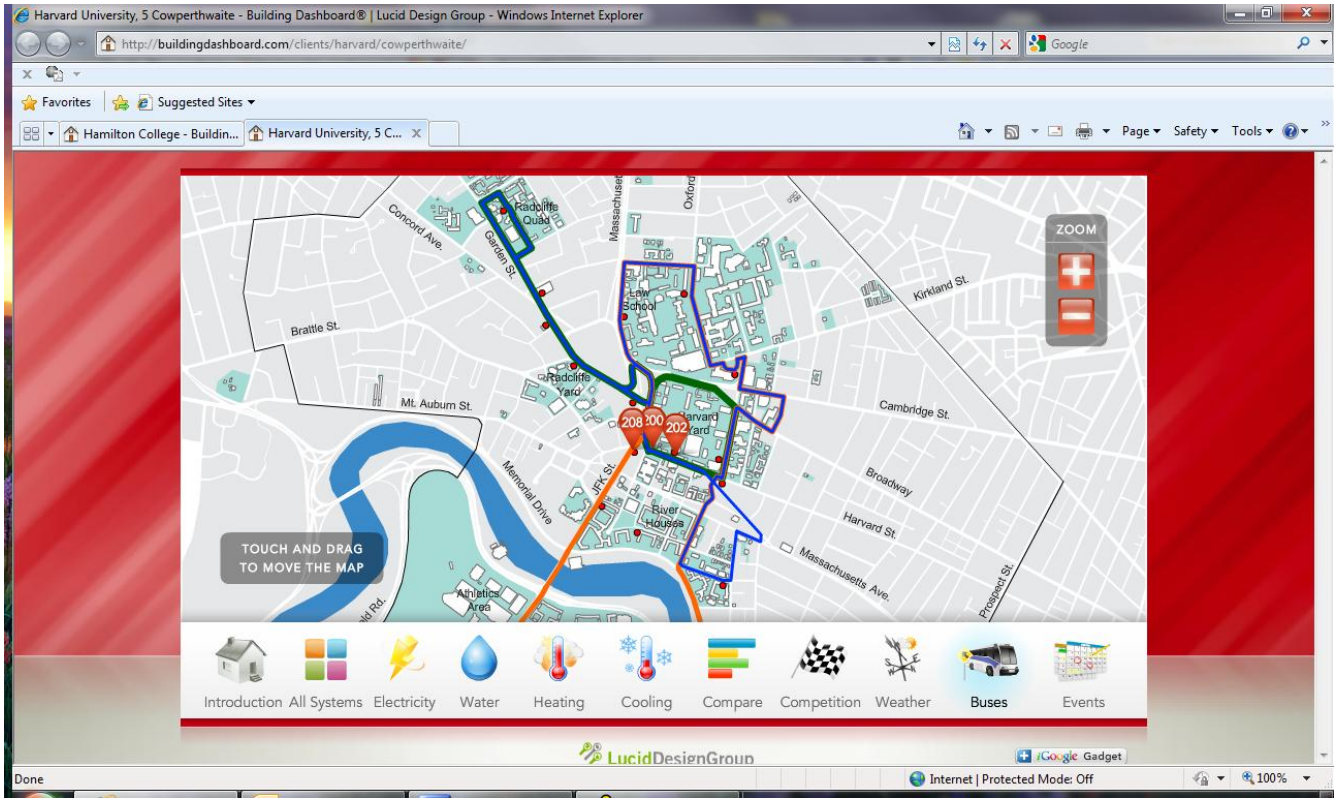

Figure 6. Shuttle Tracking through Building Dashboard at Harvard University

Residence Hall Competitions

The idea behind a residence hall competition, or a "dorm" competition, is to encourage residents to consume less energy by holding a competition to see whose building could save the most energy. This of course not only raises awareness of being sustainable and helps to develop less wasteful habits among students, but it serves as an effective way to save the campus some money from its monstrous utility bills. These competitions are usually held for a few weeks, and last at least a month. Usually the winning residence hall will be rewarded with a prize of some sort, usually a pizza or ice cream party. Ideally, the prize is mere fraction of what is saved overall in utility costs, which makes every residence hall competition not only an opportunity to connect to the residents but as a way to save money by reducing energy consumption costs.

Clark University

After implementing their internal metering system in 2008, Clark University has only had one residence hall competition in the fall of 2009. They ran the competition for six weeks, and ultimately saw a

savings of $1,448, or about 3.8%. The savings costs were compiled by comparing the electric consumption rates they had recorded from the previous year to what was currently being consumed. Clark University is very close in size to WPI, and has over 1,700 students living on-campus, about 150 more than that of WPI.[21] Also to note, they did not have values for the first week of the competition, and the difference saved in the second week was quite minimal, only 210 kilowatt-hours.

	2009 BAU	Difference		
week 1	x	x		
week 2	52,824	(201)		
week 3	54,792	(2,580)		
week 4	54,790	(2,864)		
week 5	54,155	(2,900)		
week 6	45,812	(3,323)	kWh cost	$ 0.12
Net Reduction		(11,868)	savings	$ (1,448)
			reduction of	-3.8%

Figure 7. Clark University, Residence Hall Competition

Since the monitoring system for the electricity is all internal, Clark had to hold their competition by sending e-mails and posting results on posters around campus. With this set-up, the competition seems much less exciting at first since the residents cannot see real-time changes, and many students ignore campus-wide e-mails and posters. This can even been seen at WPI as well, numerous e-mails are sent every day to the entire student body, and posters for events are strewn all over campus, from within the residence halls to the academic buildings. These sources do advertise events well, but word of mouth and being persistent with advertising is key to breaking through the monotony and generating genuine excitement. A key example of this at WPI is the Recyclemania competition, which tracks how many pounds of recyclables are put out by the WPI community. Even though the competition starts in February, a lot of hype is generated for it by putting up advertising over a month in advance, and working with student organizations, such as the sorority Phi Sigma Sigma, to help spread the word and generate interest. The

[21] http://www.clarku.edu/offices/housing/

results for Recyclemania are sent by e-mail akin to how Clark University was showing the updated stats for their residence hall competition. As seen by the weekly results of the competition, word of mouth helped to boost the results, as there was a significant jump from week two to week three, going from 201 kilowatt-hours saved to 2,580 kilowatt-hours. With each following week of the competition more and more people knew about it, and the amount saved increased, leading to a total of 11,868 kilowatt hours, about 3.8% less than the previous year.

Dave Schimdt, Clark University Sustainability Coordinator, stated that the reduced energy usage was seen even after the six-week competition. This shows that not only can these competitions raise awareness and save money, that they can help to build better energy usage habits in residents and work to save money year long. Even though 3.8% seems like not much of a break, a stronger advertising campaign would definitely work to bolster results, especially when more people know what's going on from previous competitions. Working with student organizations and possibly other departments would be a better way to continue with the current system, as different e-mails and posters from different sources would reach difference audiences and might have some better ways to advertise the competition.

The project group believes that Clark's competition would be much more successful if they were able to display their real-time monitoring system in such a way for the campus community to view at all times. It would make the competition more exciting as well as competitive, and make it more clear to the residents how they're making a difference by changing up their daily routines. Dave Schimdt also agreed with idea, and stated that "On a more serious note, the data that sub meters generate can also be leveraged for greater reductions through real-time reporting – either on a webpage dashboard or in kiosks in individual buildings." He also mentioned an example of such as system that he has looked into, called TellEmotion.[22]

[22] www.tellemotion.com

Figure 8. Pasha, the TellEmotion bear

The TellEmotion system is basically a graphical interface of a cute looking bear, and when the campus is saving electricity, the bear is more animated and lively, while when the campus is over consuming, the bear is sad and sluggish. Although it's not as numbers-intense as some other systems, it's an interesting concept and is a way that might appeal better to Clark's campus community. The fact that Clark University is looking at ways to display their real-time monitoring of their electricity consumption, especially in order to bolster campus awareness and strengthen the appeal of their residence hall competitions, is important to note considering WPI is of a similar size and make-up of that of Clark University.

Hamilton College

Hamilton College uses the Building Dashboard system by Lucid Design Group[23] and has held two residence hall competitions. Hamilton has meters tracking the electricity usage of fifteen different residence halls, which house a total of 955 students, about a bit less than two-thirds of WPI's on-campus residence. They have saved $5,929 in their first competition between eleven buildings, which took place over two weeks during April 1st, 2009 to April 14th, 2009. Hamilton's second competition, which took place between November 9th, 2009 and December 6th, 2009, saved a bit more, and the average reduction between the two competitions is about 10%, about $6.21 a resident. This reduction is considerably higher than Clark University's savings of 3.8% with their strictly results by e-mail method. Also, Clark's competition lasted for six weeks while these competitions have lasted between two weeks and four

weeks. This is important to note as it is an example of how much stronger having a real-time monitoring system is than that of a system where the community cannot see the results dynamically.

Figure 9. Competition Tab of Hamilton College

Worcester Polytechnic Institute

At Worcester Polytechnic Institute, a residence hall competition has never been fully successful due to Morgan Hall, Daniels Hall, and Riley Hall being tied to the main meter. Due to this, it is impossible to hold a balanced residence hall competition since about 637 residents would not be able to actively participate. Also these 637 residents are composed of basically 619 freshmen and 18 upperclassmen resident advisors. Freshmen are most likely to be active participants in competitions between buildings, which can be seen with the successful Go Cross Campus[24] competitions where residents play an interactive online strategy game that relies on WPI buildings fighting each other.

[23] http://buildingdashboard.com/clients/hamilton/
[24] http://www.gocrosscampus.com/

Table 3. WPI Residence Halls

Residence Hall	Population	Classification
Morgan Hall	299	Freshmen
Daniels Hall	168	Freshmen
Riley Hall	170	Freshmen
Stoddard Complex	180	Freshmen
Founders Hall	231	Upperclassmen
Fuller/Ellsworth Apartments	184	Upperclassmen
East Hall	230	Upperclassmen
Institute Hall	72 (2009-10) 87 (2010-11, basement)	Freshmen(09-10), Upperclassmen (10-11)
Salisbury Estates	16 (2009-10) 16+ (2010-11)	Freshmen(09-10), Upperclassmen (10-11)
TOTAL	1565 (2010-2011)	

As seen by the above table, the current amount of residents in buildings that would be metered is about 1,565 residents. The exterior houses, such as 16 Elbridge and 26 Hackfeld, were ignored as they probably would not be worth installing meters for simply because of the lower populations. With the 10% estimated drop from the Building Dashboard system as seen by Hamilton College, WPI could easily save at least $7,000 for each residence hall completion. This figure ignores Morgan, Daniels, and Riley Hall as well, since currently there is no way to estimate the usages of those buildings. If those three buildings were to be individually metered, that would add an additional 637 students, 637 sets of laptops, fridges, and televisions, which could partake in the residence hall completion. If the 10% rule still applies, that could be potentially a saves of about $11,805 per residence hall competition! Ideally, the Office of

Facilities could work towards hosting two residence hall competitions a year, and get another department such as Residential Services or student organization to cover the mere $100-200 for prizes such as a building wide pizza party. Even at a percentage of 3.8% that Clark University saw with sending out e-mails, the campus could still save an easy $2000 a competition, and that could essentially be attempted currently.

Ideally, the thing that needs to happen is that Morgan, Daniels, and Riley need to be metered in some fashion, as well as some of the other twenty-six buildings tied to that one electricity meter. There are people living on campus nearly all year round, so competitions could even be held during the summer camps. The need for residence halls on campus is growing, and this can be easily seen over the past two years. East Hall only provided 231 more slots for residents, and even that is not enough. Morgan Hall was recently "tripled" up in the summer of 2009, and there are currently 50% more students living there, with about 96 residents per floor. Mark is currently a Resident Advisor on Morgan 2, and he can attest to every room in the building having at least three laptops or desktops, and most rooms have two fridges, a microwave, and a television. Next year, for the class of 2014, forced living will be put in affect again so there will be forced triples and quadruples, primarily within Daniels and Riley hall. Even though Admissions says they're capping applicants, the class sizes have grown over the past few years, with 954 being the highest this campus has ever seen, thanks to the class of 2013. WPI needs to really look down the road, to see that residence halls will become even larger consumers of utilities, and that putting in a system like Building Dashboard will help to save the school money through competitions, but will also build better habits among these 1565 and more residents which will make WPI more sustainable.

Cost-Benefit Analysis

The Clark system is very similar to that of the E-Mon D-Mon project, and will probably cost WPI an upwards of 100,000 dollars to meter about thirty buildings on campus. From there with meters in place, the Building Dashboard system would cost $9995 for the starter package, probably another $10-20 grand to hook everything up to the internet, and simple $2000 yearly fee to maintain the system. In total, the

implementation of around 26 meters and adding in the Building Dashboard system would be no more than $150,000 and would slowly pay for itself over time. Without a nifty graphical interface like Building Dashboard, residence hall competitions will not be as successful and maybe not even worth the trouble. At two competitions a year, saving about $7,000 a piece, the system could pay for itself in about a decade strictly on those competitions. The amount of savings that would come from developing better habits, being able to detect problems in their infancy, being able to try more green solutions, and other benefits are extremely invaluable and probably would cause the system to pay for itself even sooner.

Also, both the E-Mon D-Mon metering project and the Building Dashboard systems are scalable, so the focus could be put on important buildings and residence halls first. Next, residence halls competitions could be strongly advocated, and the savings for those could be used towards putting a few buildings onto the system every year. Elio Chimento, master electrician from Clark University, believes that their system will pay for itself within ten years, and has already started to see small amounts of savings by being able to have extreme control over their utilities usage. With more 24 hour labs being put in place, more renovations occurring to places like Gordon library, and with more students moving on campus, it is very important to get some sort of metering in place of those twenty-nine buildings, as energy consumptions will increase and WPI needs to be able to track those changes reliably.

Conclusions & Recommendations

From this project, three major areas were explored, and for each of these areas a set of recommendations has been compiled. These recommendations are critical towards revamping how utilities are dealt with at Worcester Polytechnic Institute, and it is understood that they may take a decent amount of time, work, and money to properly implement.

Billing

Worcester Polytechnic Institute handles its bills in a relatively efficient manner, but only when it comes to paying the bills. Due to campus policies, only paper bills can be used from the utility companies despite the fact that for most utilities, a bill is sent for every individual building. As the project team was examining the system, it was quite impressive that bills were not lost in the system, considering how there are nearly over one hundred bills for a single billing period for just the electric and gas meters every month. Added up over the course of a year, that's over 1,200 bills, and if the campus really keeps records of up to seven years, that's over 7,800 utilities bills floating around in various locations on campus. As far as the project team discovered, many copies of the bills are made, so that number could be essentially doubled as the Office of Facilities as well as Accounting generally have a copy. The scary thing is that through exploring the system, and attempting to hunt down the old bills, only some bills from 2006 through 2010 could be found, meaning that bills from 2002 to 2005 were lost somewhere in the vicinity of Worcester. Especially considering how not all of 2006 bills could be tracked down - there are over 6,000 that are unaccounted for. This is quite scary as Worcester Polytechnic Institute is leaning towards becoming more green and sustainable, but still relies on strictly paper methods for its billing, which applies to almost every single department and student organization on campus. Recently there have been changes towards saving paper, especially with the example of changing paystubs over to being strictly electronic based, and hopefully this trend continues through other areas of Accounting.

The project team was able to identify and examine bills through incoming bills for current months, bills from 2006 and 2007 that the Office of Facilities had, bills from 2006 and onwards that National Grid

and NSTAR had on their website, and various bills from 2006 to 2008 that were stored on ImageSilo. The team entered in information from bills into Microsoft Excel spreadsheets, and examined how bills are currently recorded. Currently, Marylou Horanzy has a history from when she started working in 2008, containing strictly the cost per unit and overall cost for each meter. The project team met with Roy Cordy to learn more about how the bills worked, and learned about the current system and ImageSilo from Marylou Horanzy. In terms with communicating with Accounting, the project team had contact with Charlene Bellows, Director of Accounting & Financial Reporting, who directed the team towards exploring the ImageSilo system. According to Charlene, Accounting keeps up to seven years of previous bills, and that she was not sure where all of them were located. It seemed that with more time and effort, these bills could be uncovered, although it would be a difficult and tedious process, especially if the bills were not stored in an organized fashion. The project team also looked into what records the utilities companies had, and their representatives directed the team towards the records stored online. For NSTAR and National Grid, their websites only had bills from 2006 through 2010, so anything past that was unobtainable.

In terms of recommendations for the Office of Facilities, the key issue is that the current system is unable to properly maintain a history. The project team feels that Marylou Horanzy's spreadsheet for entering key bill information is a great starting point for building a history, and that it can easily be expanded to include more information from previous bills and be easily maintained for support in the future. If someone else ever takes over the position or if the responsibility of data entry changes, the system is very clear and will be very easy to pick up. Although Microsoft Excel spreadsheets might be a bit too simple, it's worked for Roy Cordy at Clark University for years and gets the job done effectively.

The next step for the Office of Facilities is to start its own collection of bills. It would be as simple as scanning in bills as they come in, and saving the PDF files into a collection of folders. The folders could be organized by utility, then by year, and then finally by month. The bills would need to be scanned and

named in a consistent manner, and organized the same way for every utility. This collection of bills would definitely be stored on Marylou Horanzy's computer, and possibly saved on the Office of Facilities fileshare so that anyone within Facilities can get easy access to these bills. The idea behind Facilities starting its own collection of bills is that it does not need to worry about inconsistent scanning that was prevalent in systems such as ImageSilo, and that Facilities does not need to worry about where the bills go after they have been paid. Ideally, it would be a good idea to keep better track of where the bills go, and develop a closer relationship with Accounting so that these bills could be easily re-obtained when needed. Looking into electronic billing would solve many of these problems, and may be a solution in the future.

The last recommendation regarding bills is that the Office of Facilities looks into database solutions to create a history that could be easily maintained and useful enough to do sorting and creating trends from. From what was discussed with representatives from the CCC as well as Facilities, the ideal system that would be preferred is one that can be easily updated and maintained as the years go on. Mark from the project group explored creating a database solution with using low-level SQL queries and Perl to display the information, and it was very archaic and very tedious to update with new attributes. The project group explored using Microsoft Access as a database system, and it was quite easy to pick-up as well as to update. The fact that data could be imported from Microsoft Excel spreadsheets was quite appealing, as previously entered data that the Office of Facilities currently has could be easily added. The Office of Facilities should explore using corporate software such as Microsoft Access and Maximo to create a database, as it would be important to creating a history and would have corporate support that the campus already subscribes to. Another interesting idea, especially behind Access, is that users can input data, so bills could be streamlined down to forms that would put the information directly into the database. The project team feels that these database solutions are worth investigating, and would provide the Office of Facilities with an organized and robust system for creating their own history of utilities information.

Metering

The way that meters are currently handled at Worcester Polytechnic Institute was another interesting subject that was explored during the project. The original scope of the project had very little to do with the actual meters on campus, and was focused more towards creating a database solution towards creating a utilities usage history for WPI. Once the project team learned that there were twenty-nine buildings, many of them being large substantial residential and academic buildings, on the main electricity meter located in the Power Plant, they began to expand the focus of their project towards why this was and what other problems could be attributed to it.[25]

The main problem with having so many buildings on the same meter is that there is no way for the campus to figure out if there is anything wrong with the bills for that one meter, as there is no way to differentiate between different buildings. This problem expands when you look at other things such as residence hall competitions and implementing building renovations and tweaks. How can you hold a successful residence hall competition if you cannot include Morgan Hall, Daniels Hall, and Riley Hall, which attribute to about 632 students, which is about two-thirds of all freshmen and forty-two percent of all on-campus residents? How can you renovate buildings such as Goddard Hall and Gordon Library, and be sure that you've renovated them to meet energy standards so you can call them "green" buildings? How can you do energy saving projects such as working to turning off more lights or installing better light bulbs, if you cannot monitor the electricity of an individual building? How can you tell if an individual building is having electrical problems if its increased costs are hidden within the cost of twenty-eight other buildings? These questions go on and on, and really make it apparent that being able to individually track these buildings would not only be an asset but a necessity.

The project team also learned that the Office of Facilities had not really figured out where all their meters are located, and only had some lists of what meters they had on campus and what account numbers they were linked to. With new meters being added all the time, such as Gateway Park Garage and

the new Facilities building on Lee Street during the course of the project, it seems like a better system should be implemented in order to keep track of the meters. Other examples for the future are the meters for the new Athletics center as well as the slow process of taking back Salisbury Estates for student residence, which would place the financial responsibility of those meters upon WPI. Throughout the course of the project, the project team double checked Facilities' records by visiting all of the meters. They verified the account numbers and meter numbers, and took a picture of each meter. A map system was created using basic HTML that had the meters of all major academic buildings for electric and gas.

For recommendations regarding meter management on campus, the project team strongly encourages the use of the HTML meter map by the Office of Facilities. The system was demonstrated to Mike Lane, Director of Facilities, and Marylou Horanzy, and both of them found it to be a useful tool to the Office of Facilities.[26] Ideally, the map should be placed online where members of Facilities can have easy access to it, so that it can be accessed in a variety of ways, such as helping a company representative find a particular meter or providing assistance for emergency situations. One example of a hard to find meter was the electricity meter for Founders Hall. Several members of Facilities were called and not even Campus Police knew where the meter was located. It was eventually found to be within Campus Police's office as well, which is somewhat crazy, as if there was ever an emergency in which the meter needed to be accessed - no one knew where it was and it wasn't in an area that could be easily found. Other recommendations for meter management would be to keep better tabs on meters including things like updating addresses for meter bills and updating any meter lists on a constant basis.

Other things that should be looked into are relocating the Kaven Hall gas meter which is in an illegal position, and moving things out of the way of the Morgan/Daniels gas meter. Meters should be visited occasionally, and should be checked against what the companies are billing. Also, the Office of Facilities should maintain their relationships with company representatives, as they can be a useful asset

[25] List of the twenty-nine buildings in Appendix F

in dealing with meter management. For example, Tom Angelo, NSTAR representative, actually came around with the project team to examine the gas meters. This relationship is important for getting meters repaired faster, and they would be more likely to point out things that need to be fixed or looked at. The project team feels that these changes would allow the Office of Facilities to become better organized in its meter management, and would be more aware of problems that can occur and how to fix them.

Monitoring

At Worcester Polytechnic Institute there is currently no working real-time monitoring of the utility usage of any building on or off campus. The only actual way to have real-time meter monitoring is to actually go to the meters themselves and record the values that are seen. Once the project team learned about the twenty-nine buildings on the single electricity meter, it was clear that the solution would not simply be adding more meters. Having more meters is not that helpful if they cannot be tracked in a way that is more dynamic than waiting for the bill at the end of the month. The project team learned about the system at Clark University through several meetings with Roy Cordy, Clark University's own chief engineer. Clark University underwent a recent project which retrofitted electricity meters onto all of their important academic and residential buildings, and through a company called Schneider Electric they purchased a software package that would allow them to view the usage of their buildings in real time. This system has worked wonders for Clark University, as they can now host residence hall competitions and be able to identify problems with their buildings in real time. The project team also met with Chris Salter and Norman Hutchins, representatives of the Office of Facilities and HVAC, who have looked into systems in the past and have begun to implement an in-house metering project of buildings tied to that main electricity meter with E-Mon D-Mon internal data meters.

The second part of meter monitoring is how the information is displayed to the campus community. The project team learned that Clark University's monitoring system is strictly private, and the

[26] Presentation located in Appendix V

way that they did their residence hall competitions was e-mailing out the results, similar to that of how Recyclemania is promoted at WPI. Another system, called Building Dashboard, is used by many other colleges, including Hamilton College and Harvard University, and allows for a dynamic and real-time updating interface that the community can see and interact with. This system is similar to the LaundryView system that is used by many residents at WPI, and the project team got in contact with Lucid Design Group, the creators of the system. The project team learned more about the system and got some rough pricing estimates through a conference call with Kai Mak, a representative from the company. The system is quite dynamic and would indeed work with the E-Mon D-Mon meters that are currently being installed.

The project team recommends to the Office of Facilities to continue with its E-Mon D-Mon metering project. It is important for the campus to be able to meter its own buildings, especially those tied to the main electric meter in the powerhouse. If possible, it would be ideal to look for funding to expedite the project, as it would be cheaper to do more meters at once and the returns from internal monitoring will take a while to show up. The project team also recommends for the Office of Facilities to subscribe to the Schneider Electric dollar a day program through National Grid. For only a mere $365 dollars a year, Facilities would be able to see what the National Grid meters are seeing on a daily basis, and would be key for indentifying problems with meters and an easy way to keep up with the monthly bills. The system is also used at Clark University and is found to be quite useful on keeping tabs on National Grid.

The project team also strongly supports the idea of looking at web-based interfaces to help get the WPI community involved in getting excited about sustainability and work to save the campus money. The Building Dashboard system is quite enticing, as it is relatively affordable, practical, and the company will work with WPI to create neat software applications that will best work to reach out to the WPI community. The only roadblock for a system such as the Building Dashboard is that it is essentially a “cloud” solution, as all of the data would be stored on servers owned by Lucid Design Group, rather than

WPI. These cloud solutions are not preferred by the Office of Facilities as the control leaves their hands and they are essentially locked into a contract. However, this would lead to a solution that would be more homebrew, perhaps created by a group of students. The problem with this is that it will most likely not be able to be maintained and sustained once those students graduate and leave WPI, which is somewhat contradictory. The system cannot both be fully internally controlled while being able to be maintained and be of high quality.

The project team has a compromise which would cater to the Office of Facilities as well as be able to be maintained and kept up to date. The solution is to use the E-Mon D-Mon monitoring abilities as the internal solution for the Office of Facilities, similar to what Clark University does. The Office of Facilities would be able to get all of their internal data, and Network Operations would be able to have control over the networking required to make this happen. Then, in order to reach out to the community, work with a company such as the Lucid Design Group to supply the software for the external solution. The E-Mon D-Mon meters would work with the system, and it would not affect the Office of Facilities if the meter information was also sent to the cloud solution for something like the Building Dashboard. This way, both the Office of Facilities and Network Operations would not have to deal with maintaining the system that the community sees, and the Office of Facilities can use this opportunity to focus on coming up with neat ideas for applications and promoting residence hall competitions through the external system.

Outside of the initial costs to set-up the Building Dashboard system, residence hall competitions will easily save enough money to pay for the yearly cost of $2000 to maintain the system. If external funding can be found, to pay for the E-Mon D-Mon metering as well for the costs to set-up the Building Dashboard system, it would be worthwhile. We recommend that the Office of Facilities looks for external funding, as this whole system will not only save the campus money but increase its sustainability profile and help build a stronger community at WPI.

With real-time monitoring in place, there come many advantages with regards to utilities usage. The ability to host residence hall competitions and "black-out" events in a way that members of the community can see the changes is huge, and will increase campus participation. These systems would not only encourage students to be more sustainable, but could be used to encourage faculty and staff members as well. Being able to monitor buildings internally will allow the Office of Facilities to be more comfortable with more "green" renovations, as they can be tried on a small scale. If the renovations seem to make a substantial difference, they can be applied with confidence on a large scale throughout campus. The Office of Facilities can be more confident in their decisions concerning utilities usages, simply because they have hard numbers of their own.

Real-time monitoring will allow for more involvement on campus, and give the Office of Facilities and its sustainability a larger name on campus. National Grid actually gives out grants for green projects, and if WPI is able to see if renovations save energy and money, they would be able to apply for most of these projects. Projects such as replacing light bulbs with more efficient ones, and establishing ways to encourage shutting down of classroom computers and lighting could be attempted, and if noticeable differences are seen, these projects could be more heavily supported and continued. Another benefit is that WPI will be able to check its meters against those of other utility companies, and give it more backing in the bidding process when renewing utility contracts.

The biggest drawback to these monitoring solutions is the large cost of setting the systems up, but things should be looked at on a larger scale. Electricity costs for Worcester Polytechnic Institute are in the scale nearly a hundred thousand dollars a month, reaching over one million dollars for a year – and that's just for electricity. More and more students are being admitted every year, there is a need for more on-campus residence halls, more renovations are taking place, and more extravagant buildings are being built on this campus. The costs of utilities is only going to increase as the community of Worcester Polytechnic Institute grows, and the cost of implementing these monitoring systems would only cost the

campus an upwards of two-hundred thousand dollars. This is a mere fraction of what the campus pays every year for utilities, and there is no good reason that the campus cannot differentiate between twenty-nine buildings simply because they are tied to a single meter. The project team feels that in order for Worcester Polytechnic Institute to truly gain control of its utilities usage, it needs to get out of the mindset that utilities bills are simply meant to be paid, and should strongly consider implementing systems that would give it that control.

Future Work

Through the completion of this project, the project team saw many opportunities for other groups to either carry on the work that was done, or explore other options that dealt with similar themes and concepts. If any of the aforementioned recommendations were to be implemented, it would lay the groundwork down for a variety of projects, especially for students via IQPs and MQPs.

IQP

The project team felt that IQPs, interactive qualifying projects, would probably be the best way to continue on the work done in this process, especially if it takes time for any of the recommendations to be strongly considered. These IQPs would be focused on either continuing the project team's work directly or exploring other systems on campus where similar techniques could be applied.

A direct continuation of this project could take one of many forms. Ideally, these extra groups would try to specialize in one of the major areas the project explored, such as improving billing, keeping track of meters, or coming up with ways to project the information to the community. This way, these project groups would be able to come up with stronger sets of recommendations, and perhaps explore how more colleges handle their utilities.

With regards to improving billing, there are many options for these IQPs. They can expand upon the database solutions which the project team looked at, primarily examining Microsoft Access and Maximo, both proprietary software that the campus already has licenses and support for. Exploring the database solutions would involve figuring out which program is easier to use and which one gets the job done properly. These groups would figure out the best way to separate bills, such as having different databases for different utilities or finding the best way to organize everything into one larger database. Turnover in the position is also an important thing to look at, as Marylou Horanzy's position may not always be in charge of bill entry, or someone else may be in the position. For example, over the last summer, the Office of Facilities had a workstudy input some bills on their own. Whatever system is chosen

not only needs to be affordable and efficient, but it must be easy to use in order to teach other people how to use it and how to update it with new fields and tables.

Another angle to examining the billing is attempting to collect more of the older bills, and input them into Microsoft Excel spreadsheets. The project team hit some road blocks with Accounting in terms of gaining access to old bills, but if a group was more persistent, and perhaps had someone from Accounting be involved in the project, they would have a better chance at getting access to the older bills. It seemed that one of the main problems with Accounting is that they themselves do not necessarily have their archived bills organized neatly. The organization of Accounting's archival of old bills could be another IQP or MQP in itself, finding ways for the bills to take up less room and how to archive them in a more efficient manner. Other things that these groups can look into are coming up with a solid system for the Office of Facilities to archive bills on their own, so that they do not need to worry about what Accounting and other departments on campus do with them. Another thing that these groups can look into are the services provided by the utility companies, and see if there are any that would make maintaining old records easier. The project team only explored the services provided by NSTAR and National Grid, so it is possible that the companies responsible for supplying the utilities, Hess and Direct Energy, may have different systems in place for obtaining old data records.

The continuation of this project in terms of meter management would be extremely useful. Even during the course of this project, several new meters were added such as the Gateway parking garage and the new Office of Facilities down on Lee Street. Future IQP groups could work to expand upon the provided map, adding more meter information and adding new meters. These groups could also work to obtain updated campus maps, and perhaps more detailed maps that focus on the off-campus areas where WPI owns property. The HTML-based maps could be revamped and optimized, and perhaps groups could look into building something in Flash, with possibly features that would allow anyone to add new meters and information without having to hardcode it in. Outside of electricity and gas, future IQP groups could

explore the locating and mapping of things such as water meters, fire extinguishers, sprinkler systems, smoke detectors, fire hydrants and even emergency shut-offs. They can use something similar to the map used by the project team, add these new meters and whatnot onto it, or create their own maps that better represent the objects at hand. For lots of the fire safety items, it would make sense if you could examine the buildings on a floor by floor basis as well, as things like sprinklers are found in more than one location per building. The Office of Facilities currently has very little work done in locating all of these things outside of some outdated lists, so examining these features would be critical in aiding the campus. William Grudzinski Sr, Chief Engineer and co-advisor to this project, is in strong support of other IQP groups tackling these areas as he believes "that the expansion of this project in the future to include emergency shut offs, fire hydrants, extinguishers, emergency generators, sprinklers, water meters, in the same map or something similar would be a great benefit for the operations of the campus." William has already discussed the possibilities with Randall Harris, a faculty member within the Fire Protection Engineering department, and Randall believes that they would be "worthy projects for IQP's."

The last major item that IQPs could focus on to expand the work done in this project would be to examine additional ways to display data, and its effect on the community. The project team explored the system used by Clark University as well as Building Dashboard, a system built by Lucid Design Group and used by other colleges such as Hamilton College and Harvard University. Future groups could look into other systems used to display utilities usage and sustainability, such as the Tell Emotion system that Clark University has looked into. Contacting other colleges and finding more about what they do would be another good angle to find information, as the project team did send out about a dozen of e-mails but got very little responses. Another thing that these groups can do is send out campus wide surveys to figure out what the general campus interest is in learning about utilities usage, and how they would change their habits if they could see usage in real-time. These project groups could do a deeper analysis of the residence hall competitions as well, analyzing the results of more colleges and looking into similar events that have been tried at WPI.

Ultimately, if any of the recommendations are to be implemented, especially the ones regarding increased self-monitoring of on campus buildings and displaying that information to the public, there would be a large amount of possibilities for IQPs that either expand upon what this group accomplished or for new ideas and angles. Over the course of the project, the team found that many other IQPs have asked the Office of Facilities, Accounting, and even representatives from Clark University for information on WPI's utilities usage and sustainability. If WPI is able to monitor their own buildings, and come up with a history of their own, they would be able to easily give this data to student groups, who could then turn around and do deeper analysis of how WPI can be more sustainable while saving money on their utilities fees. The project team feels that IQPs are great ways to continue the work that has been done, and are a great way to do deeper analyses of more specific aspects.

MQP

Major Qualifying Projects, also known as MQPs, would also be a good stepping stone for continuing the work of this project. The initial goal of this project was to create a database system to house a history of utilities bills, and then use that database to track trends and propose solutions to save money and reduce various usages. What the project team found in the process that old bills were scarce and incomplete before 2007, and that the task of building a complete database systems is quite daunting for an application like this. One of the major issues that were discussed in the beginning of the project is that many IQPs and MQPs have done software projects like these, and they become almost unusable in a few years as the people who created the system have graduated and moved on. It was recommended that proprietary software, such as Microsoft Access or Maximo, would be used so that future students and staff members could work with the database. If anything would go weary with the database, the companies themselves could be contacted to troubleshoot, which in turn would give the CCC and other WPI staff members less stress. These MQP groups could examine the different database systems, and implement one that not only can be easily updated, but can be maintained and sustained through upcoming years. A MQP group for this would consist of Computer Science and Management Information System majors.

Other MQPs could build upon the map system used for the meters, and coming up with something that is more interactive and more dynamic. This MQP group would again consist of Computer Science majors and perhaps other majors that work heavily with graphic design and Adobe Flash. Ideally, these groups would create maps that could be used to show different utilities at once, perhaps with the ability to turn on and off different utilities and resources. These maps could be used to integrate information from other IQPs, such as ones that look into water meters and fire safety. This would involve creating a system that gives a more dynamic breakdown of buildings, whether by floors or by rooms. It is possible to use Flash to create dynamic maps, so these MQPs could come up with a user-friendly system that allows users to add new meters to the maps, as well as upload pictures and data. It would be similar to how Google Maps works, which lets one pinpoint certain locations to add information and pictures. This would allow the Office of Facilities to maintain the maps themselves, without having to work heavily with complex code or having to rework the map every time something new needs to be added.

Another thing that MQP groups could look at are coming up with in-house ways to display meter information to the public. This of course would be primarily Computer Science and Management Information Systems majors, and work closely with the Office of Facilities to get readings from the E-Mon D-Mon meters that are currently being installed. It also may be possible to get those live readings from National Grid's dollar-a-day program, and use those to generate graphs. The problem behind this system is that it is a huge undertaking for a small group of students, and that the problem of maintaining and sustaining in the future is very apparent. Dave Schimdt, Clark University sustainability coordinator, mentioned that he has "put some feelers out there amongst our computer science students to see if they are interested in developing a home grown system such as this one. Perhaps this could be a joint project between Clark and WPI students?" Perhaps if a MQP group worked with a group of students from Clark University, and came up with a joint system that worked for both campuses, maybe there be more support through future generations. Again, these are issues that IQPs and MQPs will explore, and there are likely to

be solutions that could work not only fit the criteria of Office of Facilities but do the intended tasks effectively as well.

Office of Facilities

The Office of Facilities is obviously the key player in any future work that is to be done regarding the topics explored in this project. They should embrace the idea of further IQPs and MQPs exploring these topics, and take their recommendations with strong consideration. For further work in database systems for billing, meter mapping, and meter monitoring, the Office of Facilities needs to make very important decisions, especially with regarding its ideology of having control over its information and being able to maintain its projects. With things such as the database systems for billing and for meter mapping, there are many solutions that allow the Office of Facilities to have complete control over the information while being able to maintain the projects for future work. Corporate software for database systems and the idea of keeping a scanning copy record of bills is something that the Office of Facilities can easily manage and evolve as time goes on.

The concepts of meter monitoring are a little bit more complicated, as many corporate software solutions require the information to be held off-campus. One of the project group's recommendations was to use the E-Mon D-Mon system as a way for the Office of Facilities to keep its own record of utilities usage, as they can have complete control over it and keep its information on-campus. The second part of the recommendation was to then look into external solutions, such as the Building Dashboard system, for displaying the information to the campus. This would allow the Office of Facilities to be more hands-off with the actual work in implementing the system, so that they can spend more of their efforts into promoting the system and working on solutions to not only make the campus more sustainable but to save money. Another important thing is for the Office of Facilities to look into additional funding to support the E-Mon D-Mon metering of buildings as well as systems for displaying the information to the community. Both of these projects are scalable, in the way that only a few meters could be added each year, so it would not be a huge feat to get some funding each year. The idea behind sending the

information to the community is huge though, and if funding could be provided through higher sources on campus, every important building could be metered by WPI and monitored through one of these external systems. Residence Hall competitions would be a way for the system to slowly pay for itself, and if external funding could be secured, it would allow the Office of Facilities to do so much more and really advance how it deals with its utilities usage. From here on in, the Office of Facilities has a plethora of options to choose from, and hopefully it can choose the best combination that will benefit the campus the most, no matter what the cost.

Computing and Communications Center

"As part of the Information Technology Division, the Computing and Communications Center provides the communications, computing, and storage infrastructure, as well as the software utilities and applications to support the academic, research and administrative activities at WPI. The CCC continues to expand and adapt, incorporating new systems and technologies to ensure that WPI remains a leader in the use of technology in higher education."[27] In its capacity as the department in charge of maintaining server space, the CCC would need to be contacted to examine the possibilities around hosting the interactive map system for Facilities. The group devised several ways the hosting could be set up. First, dedicated web space could be obtained so that the map system would always be available online, from any web browser (for example, http://utilities.wpi.edu). With this system, Facilities would then need to determine whether or not to make this system accessible to anyone or just certain people. The group would recommend limiting its availability to Facilities and Campus Police, since there is physical plant layout information which could be used for illicit activities. The other main option would be to host the system on an already existing server share, accessible only to a group within Facilities. This option would likely be easier to set up initially but would not allow for easy viewing. The group recommends Facilities meet with the CCC staff to determine the optimal way to setup and design the system.

[27] http://www.wpi.edu/academics/CCC/

Network Operations

The "CCC's Network Operations Group (Netops) is responsible for the maintenance and operation of the data network on the main WPI campus and the satellite locations at 60 Prescott Street and 85 Prescott Street"[28] (Gateway Park and Mass Academy). As such, Netops would need to be contacted prior to purchasing and installing any network devices for monitoring utilities information as recommended by the group. These devices would need to comply with all policies and practices put into place by Netops. The group recommends Facilities meet with the Netops staff to determine the optimal way of testing and then deploying any network devices.

[28] http://www.wpi.edu/Academics/CCC/Netops/About/

Appendices

Appendix A: Project Overviews

Initial Overview

IQP – Facilities Utility Database

Basic Project Idea:

Goal: Digitize and streamline the process of utilities management at WPI. Perform simple analysis of data, provide information for future project groups, as well as staff.

- mySQL Database (needs server space, backups, can CCC manage the server and backups?)
    - Contain all previous utility information (input by us)
        - Possibility of obtaining digital records from the companies
    - Have the ability to add utility information (select set of users)
        - Possibility of utilizing digital records available from companies to input new utility information
            - Paperless (go green)
    - Have the ability to query the information, sort the information
        - Sort by things such as date, span of dates, utility type, cost, consumption, etc.
    - Needs certain levels of security:
        - Admins (add, delete, modify)
        - Power Users (add data, modify)
        - Staff Users (see all data)
        - Student / Faculty Users (see usage but no finances)
        - No public access
- Front End Integration
    - Web Browser (PHP)
    - Corporate Software (Maximo)
    - Don't want something that will become obsolete
    - Training the end users (get feedback, etc.)

Questions:

- Sorting done on mySQL or front end?

Revised Overview

WPI Utilities IQP
Sunday, September 6, 2009

PROJECT GOAL:

To digitize and analyze past utilities records for WPI Facilities, then make recommendations accordingly. There will be no implementation.

PROJECT OUTLINE:

- Digitize and store past utilities bills in some sort of database
- Analyze data:
    - By meter (electricity, gas, water)
    - By building (if available)
    - Generators (National Grid program)
    - Fire Safety (separate database)
        - Alarms
        - Sprinklers
        - Extinguishers

PROPOSED MEANS:

1. Access Database to organize data (for us to analyze)
2. Charting with Excel and Access

A-TERM TASKS:

- Meetings with William Grudzinski and Mike Ciaraldi
- Data Entry, need to obtain raw data ASAP
- Survey of Facilities / Undergraduates / Faculty
- Survey other schools (see how they manage this data)
- Begin looking at report (intro/conclusion)

B-TERM TASKS:

- Analyze Data
- Solutions drafting, create mock database images
- Report progress (keep working)

C-TERM TASKS:

- REPORT!!
- Present suggestions to Facilities
- Deploy Fire Safety Database ??
- Deploy Raw Data Database ??
- Other:

Future projects, MQPs, etc.

A-Term Summary

WPI Utilities IQP
Monday, October 12, 2009

PROJECT GOAL:

To digitize and analyze past utilities records for WPI Facilities, then make recommendations accordingly.

PROJECT OUTLINE:

- Digitize and store past utilities bills in some sort of database
- Analyze data:
    - By meter (electricity, gas, water)
    - By building (if available)
    - Generators (National Grid program)
    - Fire Safety (separate database)
        - Alarms
        - Sprinklers
        - Extinguishers

PROPOSED MEANS:

3. Access Database to organize data (for us to analyze)
4. Charting with Excel and Access

A-TERM TASKS :

- *Meetings with William Grudzinski and Mike Ciaraldi*
    - Every week, Monday 1-2 PM
- *Data Entry, need to obtain raw data ASAP*
    - August-September 09
    - Fiscal years of 08 and 09 are logged
    - Work with Microsoft Excel and Access
- *Survey of Facilities / Undergraduates / Faculty*
    - Talked with Marylou in facilities
- *Survey other schools (see how they manage this data)*
    - Met with Roy Cordy in Clark
- *Begin looking at report (intro/conclusion)*
    - Looked at other reports
- Contacted other colleges and companies
- Found digitized records online
- Began to map out meters and verify information with past data/bills

B-TERM TASKS:

- *Analyze Data*
- *Solutions drafting, create mock database images*
- *Report progress (keep working)*
    - Start writing
- Collect rest of bills + digitize
- Continue to meet with other IQP group and schools for trend ideas to look for
- Survey Undergraduates/Faculty?
- Finish mapping meters and generate high quality map

C-TERM TASKS:

- *REPORT!!*
- Present suggestions to Facilities, Accounting, and WPI as a whole
- Come up with a usable Access Database to streamline future data entry
    - Access to all previous history
- *Other:*
    - *Future projects, MQPs, etc.*

B-Term Summary

WPI Utilities IQP
Monday, December 14th, 2009

PROJECT GOAL:

To digitize and analyze past utilities records for WPI Facilities, then make recommendations accordingly. Also, to provide a digitized map of all known meter locations for electricity, gas, and water.

PROJECT OUTLINE:

- Digitize and store past utilities bills in some sort of database
- Analyze data:
    - By meter (electricity, gas, water)
    - By building (if available)
- Provide Feedback
    - Bill collection
    - Information Security
    - Infrastructure for saving money and going green
        - Monitoring buildings around the clock
        - Comparing readings to company's readings
        - Residence Hall Competitions

PROPOSED MEANS:

5. Access Database to organize data (for us to analyze)
6. Charting with Excel and Access
7. Adobe Fireworks/HTML for Mapping

A-TERM TASKS :

- *Meetings with William Grudzinski and Mike Ciaraldi*
    - Every week, Monday 1-2 PM
- *Data Entry, need to obtain raw data ASAP*
    - August-September 09
    - Fiscal years of 08 and 09 are logged
    - Work with Microsoft Excel and Access
- *Survey of Facilities / Undergraduates / Faculty*

    - Talked with Marylou in facilities
- *Survey other schools (see how they manage this data)*
    - Met with Roy Cordy in Clark
- *Begin looking at report (intro/conclusion)*
    - Looked at other reports
- Contacted other colleges and companies
- Found digitized records online
- Began to map out meters and verify information with past data/bills

B-TERM TASKS:

- *Meetings with William Grudzinski and Mike Ciaraldi*
    - Every week, Monday 11-12 PM
- *Analyze Data*
    - Compared some data to find misreading
    - Gateway Park not paying enough for water
    - Few months of Fuller Apartments missing
- *Report Progress*
    - Report Skeleton
    - Master/Slave Documents
- *Bill Collection*
    - NationalGrid and NSTAR sites
    - ImageSilo
    - Roadblocks with accounting (past 7 years)
- *Data Entry*
    - Entering in new bills as they come
    - Entering in old bill as they're found
    - Most of current fiscal year is entered
    - Large portion of 2007 and 2008 are also logged
    - Began entering in 2006
- *Other IQP Groups*
    - Kept in contact with some other groups
    - Similar ideas, no infrastructure to find the information they desire
- *Meter Mapping*
    - Located all gas and electricity meters on campus
    - Took pictures
    - Got NSTAR representative to help
    - Found many small problems (meters not existing, not being charged for)
    - Began building a map in Adobe Fireworks
    - Have electricity map of main power house
- *Other Colleges*
    - E-mailed other colleges for feedback
    - Explored several websites of other colleges who have meter readings live
        - *http://buildingdashboard.com/clients/hamilton/*

    - Visited Clark University
    - Explored Clark's program and applying it to WPI's current structure
    - Recorded and transcribe meeting with Clark Chief Engineer, Roy Cordy
- *Company Contacts*
    - Got responses from NSTAR and National Grid representatives
    - Got questions answered about how meters are read
    - Talked about cogeneration and other possible options with WPI alumn, Jim Cleary
- *Information Security*
    - Began to look into how to keep our collected information safe
    - Contacted representatives in WPI Campus Police and Net Ops

C-TERM TASKS:

- *Write Report*
- *Present suggestions to Facilities, Accounting, and WPI as a whole*
    - Get pricing for meter monitoring systems
    - Look into cheaper lightbulbs for the campus
    - Look into other energy saving ideas that could happen with real-time monitors
- *Come up with a usable Access Database to streamline future data entry*
    - Access to all previous history that was collected
    - Provide locations of where all these bills are located
    - Find any possible trends collected via the data
- *Finish Meter Mapping*
    - All known electricity/gas/water meters

Revised Overview (C-Term)
WPI Utilities IQP
Thursday, January 21st, 2010

PROJECT GOAL:

To digitize and analyze past utilities records for WPI Facilities, then make recommendations accordingly. Also, to provide a digitized map of all known meter locations for electricity, gas, and water.

PROJECT OUTLINE:

- Digitize and store past utilities bills in some sort of database
- Analyze data:
    - By meter (electricity, gas, water)
    - By building (if available)
- Provide Feedback
    - Bill collection
    - Information Security
    - Infrastructure for saving money and going green
        - Monitoring buildings around the clock
        - Comparing readings to company's readings

- Residence Hall Competitions

PROPOSED MEANS:

8. Access Database to organize data (for us to analyze)
9. Charting with Excel and Access
10. Adobe Fireworks/HTML for Mapping

A-TERM TASKS :

- *Meetings with William Grudzinski and Mike Ciaraldi*
  - Every week, Monday 1-2 PM
- *Data Entry, need to obtain raw data ASAP*
  - August-September 09
  - Fiscal years of 08 and 09 are logged
  - Work with Microsoft Excel and Access
- *Survey of Facilities / Undergraduates / Faculty*
  - Talked with Marylou in facilities
- *Survey other schools (see how they manage this data)*
  - Met with Roy Cordy in Clark
- *Begin looking at report (intro/conclusion)*
  - Looked at other reports
- Contacted other colleges and companies
- Found digitized records online
- Began to map out meters and verify information with past data/bills

B-TERM TASKS:

- *Meetings with William Grudzinski and Mike Ciaraldi*
  - Every week, Monday 11-12 PM
- *Analyze Data*
  - Compared some data to find misreading
  - Gateway Park not paying enough for water
  - Few months of Fuller Apartments missing
- *Report Progress*
  - Report Skeleton
  - Master/Slave Documents
- *Bill Collection*
  - NationalGrid and NSTAR sites
  - ImageSilo
  - Roadblocks with accounting (past 7 years)
- *Data Entry*
  - Entering in new bills as they come
  - Entering in old bill as they're found
  - Most of current fiscal year is entered

    - Large portion of 2007 and 2008 are also logged
    - Began entering in 2006
- *Other IQP Groups*
    - Kept in contact with some other groups
    - Similar ideas, no infrastructure to find the information they desire
- *Meter Mapping*
    - Located all gas and electricity meters on campus
    - Took pictures
    - Got NSTAR representative to help
    - Found many small problems (meters not existing, not being charged for)
    - Began building a map in Adobe Fireworks
    - Have electricity map of main power house
- *Other Colleges*
    - E-mailed other colleges for feedback
    - Explored several websites of other colleges who have meter readings live
        - *http://buildingdashboard.com/clients/hamilton/*
    - Visited Clark University
    - Explored Clark's program and applying it to WPI's current structure
    - Recorded and transcribe meeting with Clark Chief Engineer, Roy Cordy
- *Company Contacts*
    - Got responses from NSTAR and National Grid representatives
    - Got questions answered about how meters are read
    - Talked about cogeneration and other possible options with WPI alumn, Jim Cleary
- *Information Security*
    - Began to look into how to keep our collected information safe
    - Contacted representatives in WPI Campus Police and Net Ops

C-TERM TASKS:

- *Write Report*
- *Present suggestions to Facilities, Accounting, and WPI as a whole*
    - Get pricing for meter monitoring systems
    - Look into cheaper lightbulbs for the campus
    - Look into other energy saving ideas that could happen with real-time monitors
- *Come up with a usable Access Database to streamline future data entry*
    - Access to all previous history that was collected
    - Provide locations of where all these bills are located
    - Find any possible trends collected via the data
- *Finish Meter Mapping*
    - All known electricity/gas/water meters
- *"Tie up loose ends" with National Grid and NSTAR*
- *Contact Lucid Design for possible meeting/conference call*
    - *Building Dashboard software*
- *Learn About New Meters*

- *Pricing for rest of campus?*
- *Possible way to integrate with software to get online readings*

C-Term Summary
WPI Utilities IQP
Thursday, March 4th, 2010

PROJECT GOAL:

To digitize and analyze past utilities records for WPI Facilities, then make recommendations accordingly. Also, to provide a digitized map of all known meter locations for electricity, gas, and water.

PROJECT OUTLINE:

- Digitize and store past utilities bills in some sort of database
- Analyze data:
  - By meter (electricity, gas, water)
  - By building (if available)
- Provide Feedback
  - Bill collection
  - Information Security
  - Infrastructure for saving money and going green
    - Monitoring buildings around the clock
    - Comparing readings to company's readings
    - Residence Hall Competitions
- Look into means of Displaying Data
  - Building Dashboard

PROPOSED MEANS:

11. Access Database to organize data (for us to analyze)
12. Charting with Excel and Access
13. HTML/CSS For Mapping

A-TERM TASKS :

- *Meetings with William Grudzinski and Mike Ciaraldi*
  - Every week, Monday 1-2 PM
- *Data Entry, need to obtain raw data ASAP*
  - August-September 09
  - Fiscal years of 08 and 09 are logged
  - Work with Microsoft Excel and Access
- *Survey of Facilities / Undergraduates / Faculty*
  - Talked with Marylou in facilities
- *Survey other schools (see how they manage this data)*
  - Met with Roy Cordy in Clark
- *Begin looking at report (intro/conclusion)*

    - Looked at other reports
- Contacted other colleges and companies
- Found digitized records online
- Began to map out meters and verify information with past data/bills

B-TERM TASKS:

- *Meetings with William Grudzinski and Mike Ciaraldi*
    - Every week, Monday 11-12 PM
- *Analyze Data*
    - Compared some data to find misreading
    - Gateway Park not paying enough for water
    - Few months of Fuller Apartments missing
- *Report Progress*
    - Report Skeleton
    - Master/Slave Documents
- *Bill Collection*
    - NationalGrid and NSTAR sites
    - ImageSilo
    - Roadblocks with accounting (past 7 years)
- *Data Entry*
    - Entering in new bills as they come
    - Entering in old bill as they're found
    - Most of current fiscal year is entered
    - Large portion of 2007 and 2008 are also logged
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- *Other IQP Groups*
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    - Explored several websites of other colleges who have meter readings live
        - *http://buildingdashboard.com/clients/hamilton/*
    - Visited Clark University
    - Explored Clark's program and applying it to WPI's current structure
    - Recorded and transcribe meeting with Clark Chief Engineer, Roy Cordy
- *Company Contacts*

    - Got responses from NSTAR and National Grid representatives
    - Got questions answered about how meters are read
    - Talked about cogeneration and other possible options with WPI alumn, Jim Cleary
- *Information Security*
    - Began to look into how to keep our collected information safe
    - Contacted representatives in WPI Campus Police and Net Ops

C-TERM TASKS:

- *Wrote Report*
- *Present suggestions to Facilities, Accounting, and WPI as a whole*
    - Got pricing for meter monitoring systems
        - Clark's Schneider Electric system
        - Lucid Design Group
    - Talked with chief electrician, Frank Horanzy about sustainability projects
    - Talked with Chris Salter and Norman Hutchins about Emon Demon meters
    - Looked into other energy saving ideas that could happen with real-time monitors
        - Residence Hall Competitions
        - Clark University and Hamilton College
- *Created a Meter Map*
    - All Gas and Electric Meters
    - HTML
- *Presented to Facilities*
    - Project summary and recommendations
    - Mike Lane and Marylou Horanzy
    - Interested in content, believe we should present to higher ups (head of facilities and CFOs, etc)

Appendix B: Weekly Reports

August 11, 2009

Preliminary Meeting / Ideas
August 11, 2009

- Check libraries for books on mySQL and databases in general
    - Subjects: mySQL, Database management, etc.
- Weekly meetings through A-Term (Ciaraldi, Mr. Grudzinski)
    - Discuss progress, problems, etc.
- People to talk to:
    - Bryan (CCC, Will)
        - Test server for database
        - What is available to use and what is restricted
        - Can we use CCC authentication for our database
        - Can we host it eventually

    - Facilities People
        - What system is in use now, what would be most helpful
        - Data input
        - How many years of bills are there
- Initial data entry (archived bills)
    - Automated versus manual?
- Need to determine goals for each group member for each term (A09, B09, C10) to ensure completion of project on time

September 13, 2009
WPI Utilities IQP

Sunday, September 13, 2009

Past Week

- Decided to use Access
    - Access is adequate for this project's needs
        - Easier to enter data quickly (many bills)
        - Easier to relate data
        - Easier to create custom views to analyze data
        - Easier to format data
        - Available on all campus machines and personal machines
    - SQL Commands can be used within Access for further customization
- Shifted focus from database design / implementation to data collection and analysis
- Obtained sample of different bill types
    - Electricity
    - Natural Gas
    - #2 Oil
    - Diesel
    - Water
    - Sewage
- Began database design in Access

Next Week

- Obtaining additional bills
    - Possibility of digitized bills
- Inputting data
- Figuring out answers to problems below
- Contacting other schools in the area

Problems

- **Units water/sewage is measured in (whole campus?)**
- **Units diesel is measured in**
- Company reps
- **Address to use?**
- **Different account numbers on NSTAR bills**
- **Customer charge on NSTAR and National Grid**

- **Due date on NSTAR?**
- **What buildings are fed by which meters?**

September 14, 2009 (Meeting Notes)

- Look into GUI of final implementation
  - Think of what user will expect from the program / how will the user use the program?
  - Drop-down menus for picking locations, etc
- Location/meter entry
  - Physical location and what each one serves
    - Call company to find out
  - Locate meters on map
- Rearrange columns on table
  - meterID under account number on bill table
- Changing meter numbers, still in use??
- Different addresses for each company
  - Correspondence / Customer Service
  - Payments
  - Physical location
- Paper vs. Electronic Bills
- Account Rep Info
- Account Types
- Delivery charges for electricity/gas
  - Delivered by National Grid, commodity from Direct Energy
  - Hess and NSTAR

Find out how Clark U. manages their utilities

September 21, 2009
WPI Utilities IQP

Monday, September 21, 2009

Past Week

- Will Sr. talked with Clark U
  - Look at their database system
  - They're ready for us
  - Aiming to meet Thursday/Friday
- Went over some of the logistics regarding bills with Will Sr.
  - Still have questions left regarding bills
  - Haven't seen older bills (which will have their own parts)
- Entered more bills
  - More questions raised
- Worked on model for database a little bit
  - ER Schema
  - Some other possibilities for tying in meter + locations

- List of Worcester Schools to ask
    - Clark
    - Assumption
    - Holy Cross
    - Becker College
    - Quigsigamond
- Looked at campus maps to use for meter marking
    - Like the one used for the student directory signs
    - Need to contact admissions?

Next Week

- Obtaining additional bills + Input Data
- Get Contacts List
    - Colleges in Worcester
    - Colleges outside of Worcester
    - Representatives for Companies
- Figure out more things about the bills
- Draft Letters and Send (email + calls)
- Meter Visiting + Marking
    - Get Map
    - Figure out proper time of day to access everything

Problems

- **Bill questions**
    - **Units water/sewage is measured in (whole campus?)**
    - **Units diesel is measured in**
    - **Address to use?**
    - **Different account numbers on NSTAR bills**
    - **Customer charge on NSTAR and National Grid**
    - **Due date on NSTAR?**
    - **What buildings are fed by which meters?**
    -
- Company reps

September 27, 2009

WPI Utilities IQP

Sunday, September 27th, 2009

Past Week

- Acquired most up-to-date list of meters
    - Some meters need to be added (mostly G3)
    - New meters for apartments + down the hill
- Located all G3 Meters on Campus
    - Confirmed meter number with list

    - List on Sharepoint
    - Noted locations
        - Stoddard
        - Ellsworth
        - Fuller
        - Gateway
        - East Hall
        - Power Plant (feeds 23 main campus buildings)
    - Found some errors
        - East Hall meter listed twice
        - New meters not on list
    - Need proper keys to access all meters
        - Have to go with Will Sr. + Working Hours
        - i.e. G3 meter in Laundry Room in Ellsworth was locked (new keyset)
    - Need to go back to these meters
        - Take pictures of locations + mark on map
        - Can get some additional data that we learned via visiting Clark
            - Unit types
            - Multiplier
- Mark, Will, & Will Sr. visited Clark University
    - Notes on sharepoint
    - Met with Roy Cordy, Chief Engineer
    - Complex Excel Spread Sheet
        - Entering in the daily usage for electricity
        - Estimating daily cost
        - Comparing to predicted cost
        - Updated everyday and uploaded to a ShareDrive
            - He is the only one who updates it
            - Read by VP and few other Clark officials
    - Meter Tracking Program
        - 70,000 dollars to implement (last year)
        - Each meter is synced to the network
        - Meter readings every 15 minutes
        - Every building connected separately
        - Can be used to see usage over time on a day to day basis
        - Also allows to figure out which buildings are hitting peak and when
    - National Grid Site
        - Dollar a day
        - Schneider Electric
        - Check meters on the fly (compare their readings to actual meters)
    - Learned some key things about bills
        - Our account numbers on mass electric were off (should be the same)
        - Talked about units
        - Talked about various fees and bill multipliers
    - Will meet with again when we get new questions
- Went over some of the logistics regarding bills with Will Sr.
    - Answered more questions
- Campus Map for Meter Mapping

    - Contacted Admissions as well as Marketing & Communications
    - Diane Vanicore, contact in Marketing & Communications
        - Called and e-mailed about our project
    - Will hopefully get a digital copy of the campus map (ones that are outside Bartlett)
- Obtained more bills + began to enter them into Access
    - Older bills
    - New bills will be coming Monday, 28th
- Drafted Contact Rep + School Letters
    - Got list of contact reps from Will Sr
        - NSTAR
        - National Grid
    - No definite reps for smaller companies
    - Looking for Professor Ciaraldi + Will Sr's approval before sending
    - E-mail + Snail Mail
    - List of Colleges
        - Assumption
        - Holy Cross
        - Becker College
        - Quigsigamond
        - BU
        - Northeastern
- Updated database model
    - ER Schema
    - Included last week's suggestions
    - Added additional information from Clark U visit
        - Meter Multiplier
        - Dealing with additional fees needs to be explored

Next Week

- Continue to input data into database
    - Old bills we got
    - New bills for 28th
- Meter Visiting
    - Revisit G3's and take picture/get new data
    - Mark meters on smaller map
    - Coordinate indoor meters with Will Sr this week
    - Coordinate outdoor meters during weekend/good weather
- Send out letters
    - Company Reps /Companies
    - Schools
- List any problems we find with older bills
    - Compile list for Will Sr.
    - Possibly schedule meeting with Roy Cordy to discuss more bills
- Look into Company supplied online tracking

- Costs
- How hard it would be to implement to WPI
- Can we access some information now?

Problems

- Bill questions
  - Different account numbers on NSTAR bills
  - Need to contact the company rep
- Meters
  - Discrepancies in list
  - Possibly run into more locked/inaccessible meters

October 4, 2009
WPI Utilities IQP

Sunday, October 4th, 2009

Past Week

- Entered Last Month's bills
  - Gas + Electric
  - Listed inconsistencies in whom the bills were addressed to
  - Cross referenced meter numbers on the bills with our meter lists
- Sent out letters
  - Company Reps
    - NSTAR
    - National Grid
  - Campuses
    - Holy Cross
    - Boston University
    - Worcester State
  - Added contacts to sharepoint
  - May need to call campus departments (some colleges were vague with email addresses)
    - Assumption
    - Becker
    - Quinsigmond
  - Will be looking for more colleges as the week goes on
- Contacted other IQP group
  - Jim Collier, Courtney Brock, Kate Wilfong
  - They are exploring raising awareness of power usage within the Res Halls
  - We are going to see if they need help with tracking buildings (separate meters)
    - Stoddard
    - Fuller/Ellsworth
    - East
    - Institute

        - Founders
    - We hope that they can help us with what trends to look for
- Meter Visiting
    - Got map of campus
    - Marked G3 meters on smaller map
    - Got updated info on G3 meters (multiplier + pictures)
    - Explored gas meters at 69 institute road (none there!!)
    - Began to list out what streets we need to visit for G1/G2/R1
        - Might have problems finding gas meters
- Got Old Bills
    - Jan 09 – present (gas electric)
    - Water/Sewage bills
- Meetings
    - Roy Cordy (Friday, October 9th)
        - Mark, Steve, Will Sr.
        - More bill questions
    - Mary Lou (Monday, October 5th)
        - Mark, Steve, Will Jr., Will Sr.
        - Ask what kind of system she would need
        - How she deals with the current system
- Began to look at time slots for B-term
    - 2 hour chunks
        - (MWF, 11 AM – 1 PM)
        - (TWF, 8 AM – 10 AM)

Next Week

- Enter in more bills + acquire more past bills for break
    - Aim to enter electricity/gas for Jan 09 – present by end of term
    - Organize and divvy up bills for break
- Meter Visiting
    - Figure out what the deal is with gas meters
        - What exactly they look like
        - Where they are
        - What to take from them
    - Track more R1/G1/G2/G3 depending on weather
- Meetings
    - Roy Cordy
        - Answer more bill questions
        - Ask about meter inconsistencies
        - Learn more about his system
        - More ways to save money
    - Marylou H.
        - What her current bill tracking process is

        - Learn what she wants in a new system
        - How she works with the companies and bills
        - How she works with other WPI departments (and who!)
    - Set up meetings with other WPI departments + campuses as necessary
- Come up with Break + B-term plans
    - Meeting times
        - Set meeting time with Professor Ciaraldi + Will Grudzinski Sr
        - More smaller chunks for keeping tabs on each other
            - i.e. we used volleyball class as a checkup
    - Divvying up data entry for over break
        - Will/Steve in the area all break
        - Mark going home from 18th till 23rd/24th

Problems

- Gas Meters
    - May not be where their bills go
    - Many bills were linked to 69 Institute road
        - No meters around 69 institute road
        - Parking lot!?
- Bill questions
    - Different account numbers on NSTAR bills
    - Will Sr has been working on figuring out the answer to that

October 12, 2009
WPI Utilities IQP

Monday, October 12th, 2009

Past Week

- Meetings
    - Roy Cordy
        - E-mailed list of questions regarding bills
        - Waiting on reply
        - Will try to meet over break
    - Marylou H.
        - What her current bill tracking process is
            - Elaborate excel spread sheet (we have it now)
            - Only for about a year and a half ago
            - WPI Fiscal year is July 1 to June 30 (08, 09)
            - Has almost everything that is online on the NSTAR/National Grid sites
        - Learn what she wants in a new system
            - More user friendly
            - Less paper based (more to do with accounting)

        - Establish a history of bills
    - How she works with the companies and bills
        - Has a few contacts
        - Enters the bills into spreadsheet
        - Forms go to accounting for other documentation
        - She's been on-top of a lot of the weird problems we've been finding on bills, such as incorrect account numbers and wrong addresses
    - How she works with other WPI departments (and who!)
        - Accounting has all of the older bills
        - Likely to give us bills, need to give them time though
        - Charlene Bellows in Accounting
- Tracking Websites
    - National Grid
        - Separate meter, separate account, separate log in
        - Pain to use
        - 1 year worth of data
    - NSTAR
        - One account, all the meters
        - Can generate paper bill view
        - Most go back between Jan 09 to July 06
- Data Entry
    - Took Marylou's spreadsheet and began to integrate August-September bills into it
        - Matching up columns and importing wisely, etc
        - May need to double check records with actual bills (workstudy entered in a years worth over the summer)
    - Located the bills in 27 Hackfeld – will be able to take whatever we need for break
        - Some bills only have the front side (summer workstudy)– may be missing vital data!
- College Rep + Company Rep
    - Still waiting on replies
    - May need to try calling up a few departments
    - Wait for any activity during break?
- Res Hall Usage Awareness IQP Team
    - Courtney Brock, Jim Collier, Kate Wilfong
    - Want to do a competition between Founders/Institute Hall
    - Will be meeting with them this week or beginning of next term
    - Mark met with Naomi Carton, their co-advisor to discuss what they wanted
- Chief East Hall Architect
    - Lynne Deninger
    - Sent her East Hall information for the past year
    - Contact through Naomi Carton + Will Sr.
- Mark's CS 3431 Project
    - http://users.wpi.edu/~cpetrie/db/companies.pl

    - Mock utilities bill system using SQL and Oracle
    - Tedious process of making queries and adding bills in Perl/SQL
    - Possible example of what could be done for the future
- Meter Visiting
    - Worked on documenting G2 meters and some Gas Meters
    - Will be finishing over break
- Ed Tufte
    - Checked out some of his books
    - Cogitative Style of Power Point
    - Quantities display on reserve – interloan library?
- Proposal
    - Task
    - What was completed in A term
    - Timeline for BC

Break/Next Term

- Break
    - Complete mapping of meters
    - Divvying up data entry for over break
        - Will/Steve in the area all break
        - Mark going home from 18th till 23rd/24th
    - Paying attention to emails from reps
    - Visiting Roy Cordy
    - Visiting Marylou
        - She was looking into the city of Worcester bills
    - Possibly visiting other schools
    - Asking Accounting for access to older bills
        - Charlene Bellows
- B-term plans
    - Meeting times
        - Set meeting time with Professor Ciaraldi + Will Grudzinski Sr
        - (MWF, 11 AM – 1 PM)
    - Data Entry
        - Acquire all data
        - Organize said data into Excel
        - Import data into Access
    - Begin Analysis
        - Graph trends
        - Look into realistic costs for adding additional meters
        - Look into costs for online systems such as Clark and other campuses
    - Begin Writing

Problems

- Bill questions
    - Different account numbers on NSTAR bills
    - Will Sr has been working on figuring out the answer to that
- Accounting
    - How far back do they keep their records?
    - Will we only get a bit at a time?
- 27 Hackfeld bills
    - Missing back side to several of the bills
    - Will this info be online with the digital NSTAR/National Grid?
    - If not, where can we get it?

November 2, 2009
WPI Utilities IQP

Monday, November 2nd, 2009

Past Week

- Outlined B-Term tasks into SharePoint
    - Tasks + Timelines + Percents + Assignments
        - Easier to keep track of
        - Integrated with outlook
        - More motivation
    - Online Bill Input (Electric)
    - Online Bill Input (Gas)
    - Input Water Bill Information
    - Obtain Meter Information/Locations
    - Map of Meter Locations (Main Campus Primarily)
    - Work with Accounting to Obtain Any Possible Prior Bills
    - Look at Past IQP Reports
    - Meet with Roy
- Accounting
    - In contact with Charlene Bellows
    - Willing to help, need to see what they have
        - Have last two years digitized
        - Not sure what else they have
    - Gave a list of vendors (present and old) and a timeframe for what we want to take
- Meetings
    - Roy Cordy
        - Planning to meet on a morning in the upcoming future
        - Possibly Tuesday in next week
        - Likely to do a video interview of recommendations for wpi

    - Marylou
        - Got us some more old bills
        - Helping to correct some of the bill addressed-to issues
    - Sergent Ellsworth
        - Helped us with finding Founders meter
        - Discussed a little about who should be accessing the types of data we're collecting
        - Need to consider possibilities of campus safety
            - Who can see it?
            - How to prevent crazy people?
        - FEMA/Homeland Security
            - Policies about publishing utilities and infrastructure
- Data Entry
    - Got water bills
    - Began to enter electricity/gas from paper/site bills
    - Late 2006 to 2009
    - Waiting on accounting for old bills
    - Began to enter in September to October bills
- College Rep + Company Rep
    - Got email + paper bills from NSTAR (Mike Thompson)
        - Only past two years
        - Lacking some information
    - No word from colleges
- Res Hall Usage Awareness IQP Team
    - Courtney Brock, Jim Collier, Kate Wilfong
    - In contact with Will Sr.
    - Helping with locations & information of meters for:
        - East Hall
        - Founders
        - Institute
        - Stoddard
        - Fuller/Ellsworth Apartments
- Chief East Hall Architect
    - Lynne Deninger
    - Compiled more East Hall info and sent
- Electric Meter Visiting
    - Finished visiting all electric meters that except:
        - Indoor meters
        - High profile meters
        - i.e. president's house (Drury + Regent)
    - Compiled list of conundrums
        - Multiple meters for some buildings?
        - Meters we're not being billed for?
        - Meters aren't billed for anything

        - Estimations (Founders in Police Dept)
        - List on SharePoint
    - Pictures + Updating Spreadsheet
    - Updated meter list
- Mapping
    - Mock power point map
    - Click a location, meter data pops up
    - Possibility of using flash
        - More elaborate zooming features
        - Pop-Ups
- Past IQPs
    - Gotten a few reports
    - Look through and get a feel for what is expected of IQP report
- Ed Tufte
    - Inter-Library Loan on his books
    - Should be here within the week

Plans for Next Week

- Meter Visiting + Mapping
    - Finish awkward locations (presidents, indoor residential, etc)
    - Gas meters
        - Will Sr. is checking them out with NSTAR Rep
        - Mark, Will Jr., and Steve will walk with as schedules fit
    - Continue with mapping
        - Add more meters to mock map
        - Organize pictures and data (sharepoint)
- Data Entry
    - Finish entering online bills from 2006-2009
    - Enter water bills
    - Hopefully get bills from Accounting
    - Mid-September to Mid-October bills are in, finish entering
- Schedule Meeting time with Roy Cordy
    - Probably 11/9, Tuesday morning
- Accounting
    - Keep in contact
- Res Hall Usage IQP
    - Help with any figures they may need
- Report
    - Read through collected reports
    - Build a skeleton of the report
    - Figure out what can be written
- Safety + Security
    - Look into who on campus to ask about liability with our data

- Look into campus policies and whatnot

Problems

- Bill/Meter Conundrums
  - Numbers not matching for a few
  - Not being billed for certain meters?
  - List on SharePoint

November 9, 2009
WPI Utilities IQP

Monday, November 9th, 2009

Past Week

- Inter-Loan Library Request Placed
  - Ed Tufte's book
  - The Visual Display of Quantitative Information
- Accounting
  - Charlene Bellows
  - Still looking into
- Res Hall Usage Awareness IQP Team
  - Courtney Brock, Jim Collier, Kate Wilfong
  - Sent data about meters locations for res halls
- Meetings
  - Roy Cordy
  - Set up for next week, Tuesday
- Looked into Screen Scraping
  - Expensive software
  - Cheaper for us to do by hand
  - Not practical to implement
- Data Entry
  - Entered in the September to October bills (electricity and gas)
  - Entered in a bunch of old bills from the NSTAR/National Grid sites
  - Began to enter in water bills
- College Rep + Company Rep
  - No word
- Gas Meters
  - NSTAR rep met with Will Sr.
  - Visited every meter and marked down information
  - Year down of meters (replaced every 7 years)
  - Location of gas meter in Kaven Hall is bad!
    - Bad location – can't reach

        - $15k + to move it outside
    - Morgan Hall
        - Tables and desks in the way
    - Health Services (Stoddard C)
        - Illegal AC unit by gas meter
        - 3 ft from any ignition source
- Meter Lists
    - Updated gas and electricity meter lists on SharePoint with collected information
    - Beg
- Mapping
    - Mock power point map
    - Click a location, meter data pops up
    - Possibility of using flash
        - More elaborate zooming features
        - Pop-Ups
- IQP Skeleton
    - Still collecting reports to read
    - Messed with Master/Sub documents in Word
- Security
    - Began to explore websites on the topics
    - http://www.fema.gov/
    - Probably need to interview people on campus

Plans for Next Week

- Meter Visiting + Mapping
    - Finish updating computerized lists
    - Finish uploading pictures into Sharepoint
    - Add meters to the Mock Map
- Data Entry
    - Enter more online bills from 2006-2009
    - Finish water bills
    - Hopefully get bills from Accounting
- Prep for Roy Cordy meeting
    - Questions
    - Video camera
- Accounting
    - Keep in contact, possibly visit
- Res Hall Usage IQP
    - Help with any further figures they may need
- Report
    - Continue to read through collected reports
    - Continue working with a skeleton of the report
- Continue to look into Safety + Security

- Look into who on campus to ask about liability with our data
- Look into campus policies and whatnot

Problems

- Bill/Meter Conundrums
  - Will Sr is looking into; sharepoint list

November 16, 2009
WPI Utilities IQP

Monday, November 16th, 2009

Past Week

- Visual Display of Quantitative Information
  - ILL got denied since they had it in the library (but on reserve!)
  - Visited Clark University to check out the book
- Utility-IQP Server
  - Meter Images
  - Bills
  - Paper
  - \\util-iqp.wpi.edu\project
  - Login with Windows username\password
- Meter Visiting + Mapping
  - Finished updating meter list
  - Finish uploading pictures onto fileshare
  - Will Sr checked out more of the meters in awkward places (President's house)
  - Met with Jim Monaco
    - ATC, Media Instruction
    - Looked into different options
      - Flash
      - ImageMap with HTML (different regions)
- Data Entry
  - Entered in more online bills from 2006-2009
    - Some accounts don't work?
  - Added some water bills
- Prep for Roy Cordy meeting
  - Finalizing list of questions
  - Video camera checked out from ATC
- Accounting
  - Had already emailed back Will Sr earlier
  - ImageSilo, suggested to talk to Marylou
  - E-mailed Marylou about it; waiting for feedback
- Report
  - Read through collected reports

    - Built a skeleton of the report + master document
- Follow Ups
    - Jim Cleary
        - NationalGrid
        - Asked about different sources + suggestions for project
    - Mike Thompson, NationalGrid
        - Asked about meters and readings
    - Tom Angelo, NSTAR
        - Asked about meters and readings
    - Marylou Horanzy
        - Followed up on inactive/replaced accounts
        - Asked about ImageSilo
- Continue to look into Safety + Security @ WPI
    - Looked into a bit more, explored more of the FEMA site
    - Need to find right people to ask

Plans for Next Week

- Meter Visiting + Mapping
    - Update lists with Will Sr's check-ups on awkward areas
    - Talk more with Jim Monaco
        - Mapping
        - What to use
- Data Entry
    - Enter more online bills from 2006-2009
    - Get access to and hopefully bills from ImageSilo
- Roy Cordy meeting
    - Tuesday!
    - Fully understand Clark's system and get his expert opinion on what WPI should do
- Res Hall Usage IQP
    - Help with any further figures they may need
- Email Follows Ups
    - Jim Cleary
    - Mike Thompson
    - Tom Angelo
- Report
    - Build upon skeleton
    - Start writing?
- Continue to look into Safety + Security
    - Look into who on campus to ask about liability with our data
    - Look into campus policies and whatnot

Problems

- Bill/Meter Conundrums
    - Will Sr/Marylou are looking into
    - 183 St, inactive meter last used in 2008

November 23, 2009
WPI Utilities IQP

Monday, November 23rd, 2009

Past Week

- Meter Visiting + Mapping
    - Updated lists with Will Sr's check-ups on awkward areas
    - More Contact with Jim Monaco
        - Adobe Fireworks
        - Allows for image mapping
        - Less tedious than HTML
        - Software is currently on an ATC computer with limited access
- Data Entry
    - Enter more online bills from 2006-2009
    - ImageSilo
        - In contact with Marylou
        - Need to visit her to access (password protected)
        - Planning on meeting Tuesday before break
- Roy Cordy meeting
    - Recorded voice dialogue
    - Access to Clark's power monitoring website
    - Discussed what WPI should do
    - Definitely got some useful quotes for report
- Res Hall Usage IQP
    - Mark talked with Jim Collier
    - Got information they needed
    - Finishing up this term
- Email Follows Ups
    - Jim Cleary
        - Sent us a bunch of resources
        - Mostly on co-generation
    - Mike Thompson
        - Nothing
        - NationalGrid policies are different than NSTAR, according to Roy, might be why so slow to react to emails
    - Tom Angelo
        - Answered our questions
        - Meters read electronically (ERT)
        - Van rides around and gets transmitting signals from meters

        - If problem with ERT, they generate estimated bill for the month
        - If consistent problem, will manually check and service as necessary
        - ERT doesn't work with G3s
        - Natural Gas Supply for Worcester is transferred "take station" on Upland Street
        - Delivered from Tennessee pipline
- Safety + Security
    - Emailed Neil Spellman
    - Former police officer and currently WPI Network Security Analyst
    - Will worked with him over summer
    - He gave a presentation during RA training about FERPA
    - Seems like he would know what to do with regards to WPI polices

Plans for Next Week

- Meter Visiting + Mapping
    - Get access to computer with Adobe Fireworks
    - Begin making a map
- Data Entry
    - Finish up 2006-2009 bills that are online
- ImageSilo
    - Keep in contact with Marylou
    - Visit Marylou to figure out the logistics of ImageSilo
    - If possible, begin to get bill data from ImageSilo
- Roy Cordy
    - Transcribe meeting dialogue into text
    - Appendix in report!
- E-Mail Follow Ups
    - Jim Cleary
        - Read into information more
        - Possibly ask more questions
    - Mike Thompson
        - Wait for reply
- Report
    - Build upon skeleton more
    - Start writing from home
    - Add in transcript
- Safety + Security
    - Follow up with Neil Spellman
    - Look for other individuals on campus to talk to

Problems

    - None for now!

November 30, 2009
WPI Utilities IQP

Monday, November 30th, 2009

Past Week

- Meter Visiting + Mapping
    - Still waiting on access to Fireworks
- Data Entry
    - Entered a few more bills from 2006-2009
- ImageSilo
    - Mark/Steve
    - Wouldn't work on facilities student computer (permissions with installing a plugin)
    - Marylou has password/account (not Bill Sr. though)
    - Goes back to 2006
    - Accounting has past 2006
    - Facilities also has hard copy of 2006-2007
    - Original bills on site
    - Several bills are in each search result
        - Tedious
        - More complicated
    - Still a viable option to get missing bills and water bills
        - Plus 2006
    - Need to talk to accounting
    - ImageSilo Usage
        - Marylou offered her computer
        - 1 -2 PM on weekdays
        - Option for getting some bills
    - 06-07
        - Get from office of Facilities
        - Get missing things from ImageSilo
- E-Mail Follow Ups
    - Jim Cleary
        - Began to read through his information
    - Mike Thompson
        - Waiting for reply
    - Neil Spellman
        - Received a response, not sure if he will be much help, but willing to help were possible
        - Email Sergeant Ellsworth to see who he'd recommend we talk to
- Updated Sharepoint Tasks
    - Completed a few of them
    - Updated some of the timelines

Plans for Next Week

- Meter Visiting + Mapping

    - Get access to computer with Adobe Fireworks
    - Begin making a map
- Data Entry
    - Continue entering 2006-2009 bills that are online
    - Get additional bills from Facilities/ImageSilo (mainly for 2006)
- Talk to Accounting
    - Try to find Charlene Bellows
    - Marylou called Charlene during our meeting, said to fill in a request
        - Need to find out if we can compromise
            - Work with original bills inside accounting?
            - PDF scan them in for accounting?
            - Avoid printing out lots of paper copies
- Roy Cordy
    - Finish transcribing meeting dialogue into text
- E-Mail Follow Ups
    - Jim Cleary
        - Finishing reading his information
        - Come up with a list of questions and email back
    - Mike Thompson
        - Wait for reply
    - Tom Angelo
        - Came up with more questions
    - Neil Spellman
        - Wait for reply and follow up
- Report
    - Build upon skeleton more
    - Add in transcript
- Safety + Security
    - Follow up with Neil Spellman
    - Look for other individuals on campus to talk to
- Sharepoint Tasks
    - Add new tasks
    - Make sure all old tasks are fully updated
        - New due dates and whatnot

Problems

    - None for now!

December 7, 2009
WPI Utilities IQP

Monday, December 7th, 2009

Past Week

- Meter Visiting + Mapping
    - Got access to computer with Adobe Fireworks
    - Began making a map
    - A few layers, wanted feedback
    - Ran into few problems,
    - Need to check with Jim Monaco
- Data Entry
    - Continued to enter 2006-2009 bills that are online
    - Should be getting October to mid November bills soon?
    - Planning on taking the 2006 facilities bills for winter break
- Roy Cordy
    - Started to transcribe meeting
    - Listened through it once through
    - Looked into speech to text (not practical, but neat!)
    - Follow Up Meeting 12/15
- Accounting
    - Debbie from Accounting
    - Only have 7 years, basement of Boynton
    - Either from 2002 or 1999
- E-Mail Follow Ups
    - Mike Thompson
        - Waiting to call
    - Neil Spellman
        - E-mailed back, saying thanks
    - Sergeant Ellsworth
        - Emailed
- Report
    - Add in transcript
- Safety + Security
    - Waiting to hear back from Sergeant Ellsworth
- Sharepoint Tasks
    - Add new tasks
    - Make sure all old tasks are fully updated

Plans for Next Week

- Meter Visiting + Mapping
    - Check with Jim Monaco
    - Continue to add things to map
- Data Entry
    - Continued to enter 2006-2009 bills that are online
    - Enter in oct-nov bills
    - Work on getting the 2006 bills
- Accounting

    - Waiting for permission to see bills?
    - Hopefully get access before break
- Roy Cordy
    - Finish transcribing meeting dialogue into text
    - Email Roy list of questions then follow up meeting
- E-Mail Follow Ups
    - Jim Cleary
        - Wait for any more responses
        - Maybe ask another set of questions?
    - Mike Thompson
        - Another email?
        - Get Will Sr to call
    - Sergeant Ellsworth
        - Wait for follow up
- Sharepoint Tasks
    - Continue to update
- Winter Break/C-Term
    - Figure out what tasks to do over break
    - Plan weekly C-Term meeting time
    - End of Term Progress Report

Problems

    - Fireworks problems

December 14, 2009
WPI Utilities IQP

Monday, December 14th, 2009

Past Week

- Meter Visiting + Mapping
    - Talked with Jim Monaco
    - Continued to add things to map
    - Figured out project system files work with Fireworks
- Data Entry
    - Oct-Nov bills not in yet
    - Worked on entering bills
    - Worked on getting the 2006 bills for break
- Accounting
    - Still waiting for permission to see bills in Boynton basement
    - Will Sr following up
        - Waiting to hear back from Rich Rogan, University Controller, Boynton Hall
- Roy Cordy
    - Finished transcribing meeting dialogue into text

    - Emailed Roy List of Questions
    - Received response from Roy; nothing attached
        - Replied to get information sent
- E-Mail Follow Ups
    - Mike Thompson
        - Got email from Mike Thompson
        - Followed Up
    - Sergeant Ellsworth
        - Got response; similar to Neil's
        - Followed Up
- SharePoint
    - Continue to update, add, and organize tasks
    - Added folders to organize documents
    - Learned how to properly move files over
- Winter Break/C-Term
    - Figured out some plans for break
    - Made end of term progress report
    - Plan weekly C-Term meeting time
        - Fridays, 10 AM – Noon

Plans for Break

- Jim Clearly
    - Continue to build list of questions
    - Digest material
    - Send follow up question list
- SharePoint
    - Map out all C term tasks
- Solidify C-term meeting times
- Enter in bills
    - Finish online
    - Oct-Nov bills
    - Get 2006 bills from facilities
    - Maybe get bills from accounting
- Work on map
- Begin importing data into Access
- Begin Writing!

Problems

- None for now!

January 21, 2010
WPI Utilities IQP
Thursday, January 21st, 2010

Past Week

- SharePoint
    - Updated old tasks
    - Added new tasks
- E-mail
    - Nick Forland
        - Lucid Design Group
        - Behind Building Dashboard
        - Aiming to have some sort of meeting
        - Figure out pricing for WPI
- Writing
    - Split up Background
    - Will – Overview of Gas Utility on Campus
    - Steve – Overview of Electric Utility on Campus
    - Mark – Current Billing System/Current Meter Management
    - Began to outline and write
    - Found another report to look at for formatting/length ideas
        - Casey Comisky, Did an IQP last E-term in London
        - Worked with a Women's Awareness group, updating their site
- Progress Report
    - Updated end of semester report
- **Accounting Updates**
    - **Will Sr.**
- **Winter Break Metering**
    - **Will Sr. got the dirty details**
    - **Installed over winter break**
        - **Fuller**
        - **Riley**
        - **Morgan/Daniels (together)**
    - **Still being set up**
    - **E-Mon D-Mon**
    - **Eventually can add other utilities?**
    - **Interval Data Recorders**
    - **Could be accessed online**
        - **Possibly integrate with Building Dashboard software?**
        - **Software from company might be alternative?**
    - www.emon.com

Plans for Next Week

- SharePoint
    - Continue to organize files
    - Continue to update tasks
- Building Dashboard
    - Wait for reply from Nick Forland

    - Look into other monitoring companies
- Accounting
    - Get final say on Boynton bills
    - If yes, work on entering rest of old bills
- Bills
    - Begin to compile what we've entered and what we have access to
    - Come up with a plan to finish data entry
    - Begin to import into Access
- Emon Meters
    - Learn more about them
        - Pricing
        - Utilities worked for?
    - Possibly find them on campus
    - Ask whoever is in charge
- Electric Meter Map
    - Find out who has digital company and contact (that electric company?)
    - Otherwise, scan it with Facilities big paper scanner
- Follow Ups
    - Marylou Horanzy
        - Possibly visit to figure out any changes/updates with billing
        - Find out if new location has helped her work? (storing more old bills?)
    - Tom Angelo & Mike Thompson
        - Figure out if we have any more questions
        - Last batch of e-mails
- Suggestions
    - Possibly meet with master electrician and other campus representatives
    - Talk about bulbs, current means that the campus is doing to save money
    - Find out if we can make suggestions based on these
- Writing
    - Break up more of the report
    - Outline and write more!
- Meter Map
    - Add new WPI meters & work on it

Problems

None currently!

January 28, 2010
WPI Utilities IQP
Thursday, January 28th, 2010

Past Week

- SharePoint

    - Continued to organize files
    - Continued to update tasks
- Lucid Group
    - Got another reply from Lucid representative
    - Gave them our availability for later this week/next week
    - Will be doing a online-ish meeting to ask questions
- Accounting
    - Will Sr. following up with accounting
    - Called Debbie this afternoon
- Bills
    - Began to compile what we've entered and what we have access to
- Emon Meters
    - Contacted Chris, okay with meeting with us
    - We will be meeting with him next week or via e-mail
    - Asking about the meters installed over campus
- Electric Meter Map
    - Contacted Coghlin about getting access to electrical map
    - Got it via email! (attached)
- Campus Suggestions
    - E-mailed Frank Horanzy, electrician about meeting
    - Talk about bulbs, current means that the campus is doing to save money
    - Will be meeting sometime next week
- Writing
    - Continued to work on background
        - Will – Overview of Gas Utility on Campus
        - Steve – Overview of Electric Utility on Campus
        - Mark – Current Billing System/Current Meter Management
    - Continued to outline and write these sections
    - Discussed some ideas of how we can to break up further sections
- Meter Map
    - Worked on map application

Plans for Next Week

- SharePoint
    - Continue to update tasks
- Building Dashboard
    - Meet with representatives of Lucid Group
    - Find out pricing for WPI
    - How much maintenance is needed
    - If it could integrate with E-mon Demo meters
- Accounting
    - Get final say on Boynton bills
    - If yes, work on entering rest of old bills

    - At least get to see where they are located
- Bills
    - Finish compiling what we've entered and what we have access to
    - Finish plan to finish data entry
    - Begin to import into Access
- Emon Meters
    - Learn more about them from Chris
        - Pricing
        - Utilities worked for?
    - Possibly find them on campus
    - Network ready?
- Follow Ups
    - Marylou Horanzy
        - Possibly visit to figure out any changes/updates with billing
        - Find out if new location has helped her work? (storing more old bills?)
    - Tom Angelo & Mike Thompson
        - Figure out if we have any more questions
        - Last batch of e-mails
- Suggestions
    - Meet with Frank Horanzy
    - Learn about
- Writing
    - Write Write Write!
    - Break up report more
- Meter Map
    - Add Emon Demo meters?
    - Add more functionality

Problems

None currently!

February 4, 2010
WPI Utilities IQP
Thursday, February 4th, 2010

Past Week

- Last Week's Agenda
- SharePoint
    - Continue to update tasks
- Building Dashboard
    - Met with representatives of Lucid Group via Telecom
    - Kai Mak, Lucid Design Group
    - What we found out

        - Attached interview notes
        - Integrating to WPI
        - Costs
        - More details about Building Dashboard
- Accounting
    - Will Sr followed up
    - Accounting thinks all old bills are somewhere off-campus
    - Done dealing with accounting
- Bills
    - Finish compiling what we've entered and what we have access to
        - 2007, 2008, 2009, 2010
            - Incoming Bills
            - Office of Facilities
            - National Grid/NSTAR websites
        - Part of 2006
            - Office of Facilities
            - ImageSilo
- Emon Meters
    - Contacted Chris Salter
    - Can e-mail questions
    - Working on a set of questions (waiting for lucid group interview first)
        - Pricing
        - Utilities worked for?
        - Are they installed?
        - Network ready?
        - Would it be possible to access for online things
- Suggestions
    - Contacted Frank Horanzy
    - Willing to meet
- Writing
    - Write Write Write!
        - Got most of background done
        - Started other sections
    - Break up report more
        - Rough break up of sections
- Meter Map
    - Add more functionality (more quadrants, individual meter info)
    - Matched electric meter pictures with map locations

Plans for Next Week

- Look into undergrad/faculty survey by email
- E-mon Meters
    - Finish list of questions

    - Send to Chris Salter
- Follow Ups
    - Marylou Horanzy
        - Possibly visit to figure out any changes/updates with billing
        - Find out if new location has helped her work? (storing more old bills?)
    - Tom Angelo & Mike Thompson
        - Figure out if we have any more questions
        - Last batch of e-mails
- Meet with Frank Horanzy
    - Learn about ways to save energy
- Writing
    - Writing writing writing!!
    - Split up sections more
- Bills
    - Finish entering in all data
    - Import into Access
- Meter Map
    - Make pretty
    - Finish for all 9 quadrants

Problems

- Meter Map
    - Not sure which pictures are which locations for the places Will Sr visited
    - i.e. president's house, provost's house, etc
    - Will Sr should know

February 11, 2010
WPI Utilities IQP
Thursday, February 11th, 2010

Past Week

- SharePoint
    - Continue to update tasks
- Meter Map
    - All 9 quadrants are accessible
    - Worked on adding more pictures/information
    - Took more pictures of on-campus buildings
    - Started to go over gas meter pictures
- Building Dashboard
    - Compiled information onto SharePoint
        - Typed up meeting notes
        - Documents from Lucid Group
    - Sent list of buildings to Kai Mak

        - 31 academic buildings
            - 11 not on main meter
        - 13 Residential buildings
            - 10 not on main meter
            - Daniels, Morgan, Riley on main
    - Waiting for updated pricings
- Met with Frank Horanzy
    - Learned about sustainability on campus
    - Compiled question list
- Emon Meters
    - Scheduled a meeting with Chris Salter
        - Likely to be Wednesday @ 3 PM
    - Compiled a list of questions to ask
        - Pricing
        - Utilities worked for?
        - Are they installed?
        - Network ready?
        - Would it be possible to access for online things
- Compiled Question Lists
    - Liz Tomaszewski from Green Team
    - Ralph in HVAC (timing)
    - Salter
    - Frank Horanzy
- Writing
    - Got more of the background done
    - Started introduction and methodology
    - Split up more sections

Plans for Next Week

- Follow Ups
    - Marylou Horanzy
        - Possibly visit to figure out any changes/updates with billing
        - Find out if new location has helped her work? (storing more old bills?)
    - Tom Angelo & Mike Thompson
        - Figure out if we have any more questions
        - Last batch of e-mails
- Bills
    - Finish entering in all data
    - Import into Access
- Writing
    - Complete more sections
    - Begin methodology
    - Split more work up

- Meetings
    - Ralph from HVAC
    - Liz from Green Team
    - Chris Salter for Emon Demo meters
- Building Dashboard
    - Get updated numbers from Kai Mak
    - Work on organizing final numbers for report
- Meter Map
    - Make more pretty
    - Add more meter information
    - Get more pictures of buildings
    - Add gas meter pictures and info to map

Problems

None for now!

February 17, 2010
WPI Utilities IQP
Wednesday, February 17th, 2010

Past Week

- SharePoint
    - Continue to update tasks
- Meter Map
    - Added more meter information
    - Got more pictures of buildings
    - Electric is done
    - Began to add and sort gas meter information
- Building Dashboard
    - Kai Mak responded
    - Building Dashboard Starter Program
        - 2 buildings online for electricity
        - Metering/Datalogger + Software
        - $9995
    - Monitoring all buildings
        - Could scale down price of starter program a bit
        - Most of cost is in hardware
    - Most likely need to get decisions from Facilities before continuing
- Sustainability Meetings
    - Compiled Frank Horanzy meeting notes
    - Meeting with Chris Salter and Norman Hutchinson
        - Thursday, 11 AMish

        - Lee Street
    - Meeting Liz Tomaszewski
        - Couldn't make Thursday
        - Will probably e-mail questions
    - Planning to meet with Mike Lane & Marylou Horanzy
        - Thursday, 2/25th, 1 PM
        - Present meter map
        - Discuss metering
- Writing
    - Most of background done
        - Electric/Gas Meters
        - Current Billing System + Metering
    - Work on introduction and methodology
        - Utility Representatives (NSTAR and National Grid)
        - Roy Cordy & Clark University
        - Meter Observations
        - Building a Meter Map
    - Split up more sections and updating master document

Plans for Next Week

- Follow Ups & Meetings
    - Kai Mak
        - Any questions that get proposed from talking with Chris Salter
    - Roy Cordy
        - Get those numbers for Clark's monitoring system
    - Salter + Norm
        - Get info on Emon Demo meters
    - Lane + Horanzy
        - Get feedback on project
        - Next path for facilities to take
- Bills
    - Compile data files
    - Import into Access
- Writing
    - Complete more sections
    - Continue to write
    - Begin to build appendix
        - Meeting Notes
        - E-mails
        - Interview Transcripts/Notes
        - Data Sheets
        - Maps (electrical map, meter map, campus map)
        - Table of meters with information + pictures?

Problems

None for now!

March 4, 2010
WPI Utilities IQP
Thursday, March 4th, 2010

Past Week

- Presentation
  - Marylou Horanzy & Mike Lane
  - Thought ideas are good, need to go even higher
  - Suggestions for improvement?
- Writing
  - Lots of formatting and setting up final document
  - Using master document to do writing, importing into final document
  - Sending what is completed to advisors today for any last suggestions
  - Compiling appendices
  - Aiming to complete by next Wednesday, 3/10
- Clark
  - Contacted Dave Schimdt, head of Clark's sustainability
  - Got numbers on their residence hall competition (-3.8%, ~$1448)
  - Got numbers on their meter installations from their electrician
    - Elio Chimento
    - 62,000 for equipment and 24 meters
    - 5,800 for server & licensing for up to 10 users
    - 6,400 for labor (in-house)

Plans for Next Week + Term

- Writing
  - Finish report on Tuesday
  - Revise and last look overs on Tuesday
  - Submit Wednesday online
  - Finish any other paper work Wednesday/Thursday/Friday
- Presentations + Awards?
  - At least another presentation to facilities
  - Possibly have a Lucid Design Group interview with facilities members present
  - Project Presentation Day?
  - Sustainability Poster Competition

Problems

None for now!

Appendix C: Roy Cordy Visits

Preliminary Meeting Notes,(9/25/2009)
Utilities IQP
Meeting with Roy Cordy, Chief Engineer at Clark University, 508-793-7255

Description: This meeting was established to learn more about the management of utilities in a collegiate environment. Roy has been working with utilities at Clark for many years. He now has a fully digitized system of tracking previous and current utilities usage for the entire campus, by building. This sheet includes finances, usage, etc. and is available only to upper management on a shared drive.

Meeting Notes:

- Peak load (demand): highest point for that period; this is what determines how much you will be charged
- More electricity demand in the summer (AC units)
- National Grid
    - Transportation costs (can't change; put in place by National Grid)
        - Transit
        - Demand (can lower the price if you lower the load; peaks)
        - Distribution
        - Energy
        - Renewable Energy: goes into a kitty for projects and special funding from National Grid; must use this money for that purpose every year
        - Schneider Electric (National Grid program); can view electricity usage on a day-by-day basis, or under a set of conditions; can output graphs, etc.
    - KVA * 9 > KW: pay KVA (http://www.dieselserviceandsupply.com/Power_Calculator.aspx)
- NSTAR
    - Demand can't be changed unless company goes to DET to get it approved
    - Summer: March-October; Winter: November-February
    - Account numbers should be the same (discrepancies on our bills, need to talk to Account managers)
    - Dekatherm: 1,000,000 BTU
    - Therm Factor: may change every few months (Gas Company samples the gas flowing through the lines every so often to take into account line loss.
- Utilities are allowed 16% profit

Questions to Ask Roy Cordy About Monitoring Systems

- Approximately how much did the system cost to install?
    - Estimated $65,000 for the meters
    - Server(s)?
    - Software
    - Licensing
    - Labor

- Was all of the installation (aside from the program) was done by Clark faculty/staff members?
- Any idea why WPI rejected the diesel engine back when Clark decided to take it?
- How does the metering system work in particular?
    - Back-end
    - Front-end
    - Hardware
    - Software
- What companies were involved in the project?
    - Meters
    - Servers
    - Software
    - Support?
- What kind of tweaks have been made to save energy based on the up-to-date readings?
- How much money has this system saved Clark University?
- When do you expect the system to have paid for itself?
- How often do you find that NationalGrid meters are being read incorrectly from your own internal readings?
- Do you have any recommendations for WPI in the area of cogeneration, electricity production, etc.?

Interview with Roy Cordy, Clark

WPI Utilities Usage IQP

This is a transcript of the interview between William Grudzinski, Jr. and Mark Hawthorne with Clark University's Chief Engineer, Roy Cordy. Items discussed include Clark University's production of electricity, co-generation, and the metering system installed to monitor electric consumption on campus.

Interview Date
11/17/2009

Transcription Date
12/13/2009

Transcribed By
William Grudzinski, Jr.

Will We've done a lot with the meters, and walking around. We figure one of the best things to do would be to get some detail of operations at Clark to make recommendations for WPI. Hopefully WPI will then work towards that. Here it seems like you're on top of things. You can actually monitor everything, whereas WPI can't. Bills come in and are just paid; no one really keeps track of it.

Roy These meters have only been installed for about a year now.

Will Oh okay, so it's a pretty new system.

Roy We've been trying to get it for years. All the steam meters were installed last year. I've been here 37 years. They asked how much steam we were producing. I could estimate, but they finally put four steam meters in on all the boilers and a hot water meter. Hot water comes from the engine; extract the heat from that to send to hot water. Down May-August (no boilers). We're monitoring things pretty fast. The engine's online right now. Can see how much energy is being produced, lost, and purchased (co-gen meter). 1982: first started cogeneration. Mass electric would pay for the surplus electricity, changed when the 20-year contract ended. No profit in selling electricity anymore. Constantly taking at least some electricity from the grid, since the plant is no longer big enough to produce power for the entire campus. Demand was around 1200 when he started, now at about 2700/2800; now more than double. Square foot area of university has doubled; everything doubled except the plant. We've been looking into buying new boilers, like WPI did. They're planning on hiring a consulting firm to come in and survey the building. Most of the information for the survey companies comes from Roy.

Will WPI is looking at generating electricity (if that'd be worth it). They used to.

Roy They did years ago, with a steam turbine up on the top deck.

Will Now they don't do any of it. They buy it all.

Roy See that plant out there? That was supposed to be for WPI. WPI rejected it. Dept. of Energy offered that to WPI first. They said they didn't want it, I guess. Been online since 1982.

Roy distributes pamphlets to Mark and Will with information regarding Clark's co-generation plant.

Roy The pamphlet is old and really needs to be updated. We're trying to get up to date and keep the plant running. My guys are great. They do all the overhauling on the engine. The only time anyone external comes in is if there is a need for certified welding (on the pressure side of the vessel). That must be done by a professional company.

Will I was just looking at the numbers and it's impressive all the money you've been able to save over the years.

Roy Exhaust boiler right now is doing about 52,000. Meter for hot water. Amount of billions of BTUs (I divide it by 1,000), this gives me 57,000 BTUs a day. Saving $30,000-$40,000 on fuel per month, just from the waste heat that comes out of that engine. We're also producing power with it; getting two byproducts from the fuel. It's very efficient. It's paying for itself. It's expensive to run. Overhauled in September/October, cost about $145,000. That is only done every 3 ½ to 4 years. If you break down that and look at what you save on cost of fuel, it really works to your benefit. Who do you have for your NSTAR representative?

Will Tom Angelo

Roy Oh he's a great guy.

Will One of the things we're doing at WPI is working with Tom to get physical locations of all the meters. Then we've been walking around getting locations and pictures and we plan to put together a website using a map feature so the meters will be easier to find, for both WPI and the gas company. It won't have any real-time monitor capability, but it will at least help with the physical locations of the meters.

Roy I've known Tom since he started at NSTAR. He's very helpful.

Will We also have Mike Thompson for National Grid.

Roy I know Mike. He's my representative here at Clark too.

Will I don't know him personally; I haven't met him. But he hasn't been very helpful or quick to reply to our messages.

Roy Mike is a great guy. He's been our representative here for years. But it might not be him, but more so the company. I've known him for years.

Will That's what our professor said. Maybe NSTAR's policies are different from National Grid's.

Roy Oh they are. I called Tom today to check a meter out. He'll be out today. If it's not working, he'll have it replaced right away. That's the type of guy he is. NSTAR and National Grid both offer good service, but like I said, I think Mike's hands are tied. I had problems getting a meter put in at Blackstone Dormitory. They were reading double-Watt what they should've been reading. Mike brought his engineer with him and spent half the day figuring out what was wrong. Anything else you want to know?

Will WPI uses NSTAR and National Grid for their main suppliers, but they also buy commodity from Direct Energy for Electric and Hess for Gas. We were wondering if Clark does something like that.

Roy We've been doing that for years.

Will Is that just for competitive pricing?

Roy If you buy commodity at a good price, you can save a lot of money. When we first started buying commodity (we were one of the first in the area), we saved about $125,000 - 150,000 a year, just by buying commodity instead of the local supplier. Sometimes you lose, sometimes you save. All depends on the market. I monitor the market all the time.

Will That's really a major goal of this project, is looking at what you are using here at Clark to offer to WPI as something to ultimately shoot for. To just be able to log on and look at what's being used by what building.

Roy Yeah, we know what we're producing, how much we're giving away or buying.

Will Now with this program you have, how does it get the information? Did you have to put special meters in all the different locations (different buildings) for it to monitor real-time. For example, you can see what your dorms are using at any given time.

Roy We had to put meters in all the residence halls as well as the academic buildings. That

metering was installed in-house by Clark electricians. Roughly $60,000. Would have been $80,000-$90,000 if Clark didn't do the labor themselves. We have competitions with the dorms. There's someone who comes over to read the meters to see who can cut the usage the most. Then they'll throw a pizza party or something for the winning dorm.

Will I know WPI has tried that but it really doesn't work since there's no way of knowing who's using what.

Roy Yeah he can see what they're using, and compare it to a history. There's a history built in the system. It costs money to put a system like this in place but I think it pays off. We can use this data to examine a usage report for one month, and then say a dorm is using double, so something must be wrong. Whereas at WPI, there is no way to see an error and catch it.

Will Yeah, we have the main meter that comes into the powerhouse that feeds almost the entire campus. It's just one giant bill that can't be broken down by building or location.

Roy Clark has two lines coming in for backup power should the generation plant go down.

Will Now I know you can meter on a building by building basis, but is your system basically like WPI where the power starts here at the powerhouse and then is distributed throughout the campus?

Roy Yes, I generate it here. Take it out then step it up to 13,800 volts to match up with National Grid. Then it goes across to control center in the library (in the subbasement) then its distributed out to each substation using A and B cable. We can feed all buildings with A or B or split the load. Distribution actually occurs at the library.

Will So is it a special type of meter you had to put in?

Roy The National Grid one is a meter we can monitor. I can tell you how much power I buy, because I'm tied in with National Grid's meter. For about $1 a day, National Grid will set this system up for you. Schneider Electric. Now see if I want to see what I bought on the 15th of November, I click this "Summary" and it'll tell me I bought 78.72 kilowatts from National Grid that day.

Will And that's your main meter?

Roy Yes, this is our main meter.

Will How many buildings do you supply on campus?

Roy 9 dormitories. 19 main academic buildings.

Will So for off-campus properties, do you do like WPI does and buy electric and gas from National Grid and NSTAR?

Roy Yes.

Will So the utilities monitoring that you have is just for the main campus?

Roy Yes.

Will This program that you have here, the sophisticated one. Was that something that you bought, or was it written for you?

Roy We didn't get taught fully what the meters can do, so we're going to bring someone in to show us that. These meters are new, so we want to know what we can do with them.

Will So is it a company that owns it?

Roy Square D is the company we bought it from. I can get that information for you from the foreman of our electricians.

Will Yeah we'd be curious to know just so we could potentially follow up with the company and tell them what we're working on. So it looks like they pretty much came in and built the system up for you: integrating the meters. Is this a program that's now hosted at Clark?

Roy Yes, it's my program. We're licensed to have 6 people using it. We can increase that if we wanted to. The director will call me and ask why we're running so high.

Will So people do actively watch and monitor this system.

Roy Oh yeah. They monitor it all the time.

Will About how much did this system cost when you first got it. The software, etc.

Roy The metering was about $60-$65,000. I don't know what the labor cost, it was done by Clark's electricians. I don't know what the program package cost either. I can get that for you though. The environmental classes come through all the time. We take a group of 10-12 through the plant to give them tours. We're saving money and the environment as well.

Will So it's really a win-win.

Roy Yep, I'm saving money and I'm putting out less pollution. I have to monitor what I'm putting out, CO2, etc. I have to put that report out to the EPA and the Department of Energy. So if you start monitoring and producing power, you'll have to start disclosing those reports. They'll want to know how much fuel it required to produce how much power.

Will The monitoring system, you can also monitor the steam between buildings, right?

Roy Nope. I'd love to have that. We monitor all electric but all the steam and hot water produced right here. We can't monitor the distribution lines. But we do have an energy management system that controls the output. If someone says a floor is cold, someone here can pull it up and show it's set at 70, etc. HVAC runs that.

Will That's pretty cool. I lived at WPI my freshman year and if one kid had his heat on, the rest of the loop was hot. There was no climate control, so we all had our windows open.

Roy All our dorms and buildings are heated with hot water. The steam goes to each building, and then heats the water to send throughout the building. The water is heated in accordance with the outside temperature. For example, the water would be kept at a higher temperature in the dead of winter, than in the spring or fall. System 7 (a computer with the old cards) was used to control the temperature of the dorms. The first year was a savings of about $80,000-$90,000.

Will Wow.

Roy Now we have more modern ones. We do monitor all the buildings. We can control the heats in all the buildings. During Christmas time, we'll set it on unoccupied (about 58-60 degrees). Then a day or two before the kids come back, we'll boost it back up to occupancy. American

Energy Management is the company that runs that. John can get us more information on that.

Will Well that's really not the scope of our project, but that's really good and interesting to know. I mean WPI has this great new heating plant, but the buildings are all old heating systems.

Roy Right you're not saving any money. You waste money when you have the windows open. The plant could be 100 percent efficient, but you lose it all at distribution. They're not gaining anything. We were always on energy here.

Will Well that's great since you were saving money and now with the wave of going green.

Mark The meter that has the 23 buildings coming off of it, if we separate those, would we lose the G3 status?

Roy No. The G3 status is the main meter. You have substations for all the buildings. You'd install the meters at those locations. Everything would still go through the main G3 meter. The installed meters would have nothing to do with National Grid; they're completely owned by us. It's great, since you can monitor what is coming in through National Grid as well. If a spike comes through the line, you can report it rather than being charged for it.

Will Yeah that's pretty cool with the metering.

Roy Yeah I think they'd save money.

Will Right, I know WPI wants to do dorm competitions but they need a way to monitor it.

Roy Are the dorms down there mostly hot water?

Will Yes. I believe so; I'd have to check with my dad to be 100 percent sure.

Roy On that system, do they just let it run or can you adjust the temperature with a valve in your room?

Will In the room, there's a knob with three numbers on it. But even if it's off, you still get heat out of it.

Roy The valves are old so they're probably leaking. They should've been jumping on this years ago.

Will Even the academic buildings are in rough shape.

Roy They should take so many buildings a year and modernize them.

Will How do the meters you installed talk to the program?

Roy Over the network. That was all set up by our guys.

Will So it was almost entirely done in-house?

Roy Yes, most of it was done in-house. Elio Chimento (Supervisor of Electricians) is trying to get a portable meter now. He can then check a suspect meter with the portable meter. He can then tell if a meter needs to be recalibrated or serviced. The portable meter is about $3,000 but I think it's worth it.

Will Well we're going to type this up and include it as part of our project. Use Clark as a

showcase for something WPI can shoot towards.

Roy Yeah I've never understood that; you guys are an engineering school, we're not. If they were to do it again here, I think they'd use a gas engine. We're running a diesel engine now. Installed back in 1982. I don't have individual gas or oil meters, just one of each.

Appendix D: Letters to Representatives

Company Representatives
Sent to Tom Angelo and Mike Thompson (10/4/2009)

Hello reps,

We are a student group at Worcester Polytechnic Institute and are working on a project that involves gathering information on the utilities usage of the school over the past several years. After collecting this data, we will then insert it into a database which we can use to analyze the usage and eventually make recommendations to the campus on any possible trends which exist.

One of our biggest challenges is the fact that as of right know, the only possible way to obtain the information regarding different utilities is to go back into filing cabinets located at the main facilities office and type all of the information into our database manually. We were wondering if there was any possible way we could obtain past digital copies of the bills from you, to help aid in inputting all of the past usage information.

We are working with William Grudzinski, the Chief Engineer of the facilities department here at WPI, who is one of the people in charge of acquiring and monitoring the usage of different utilities across the campus.

We look forward to hearing back from you, and we thank you for your time

University Representatives
Sent to facilities departments and powerhouse managements of Holy Cross, Boston University, and Worcester State on (10/4/2009)

Hello schools,

We are a student group at Worcester Polytechnic Institute and are working on a project that involves gathering information on the utilities usage of the school over the past several years. After collecting this data, we will then insert it into a database which we can use to analyze the usage and eventually make recommendations to the campus on any possible trends which exist.

We are working with William Grudzinski, the Chief Engineer of the facilities department here at WPI, who is one of the people in charge of acquiring and monitoring the usage of different utilities across the campus.

As part of our project, we thought it might be valuable to ask schools in the area what systems they may be using to store and analyze such data. We would be more than happy to meet with you in person to discuss the systems in place at your university. If this is not something you are willing to disclose, we understand that as well.

We look forward to hearing back from you, and we thank you for your time

Appendix E: Meter Table

Air Force and Aerospace Studies
35 and 37 Institute Road

National Grid Account Number: 52550-54002
Electric Meter Number: 87924159
Meter Type: R-1
Physical Location: Rear of building by staircase

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 10208270024 (35 Institute)

Gas Meter Number: P092413 (35 Institute)
Physical Location: Basement of building

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 10208280023 (37 Institute)
Gas Meter Number: P093355 (37 Institute)
Physical Location: Basement of building

Alden Hall
172 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

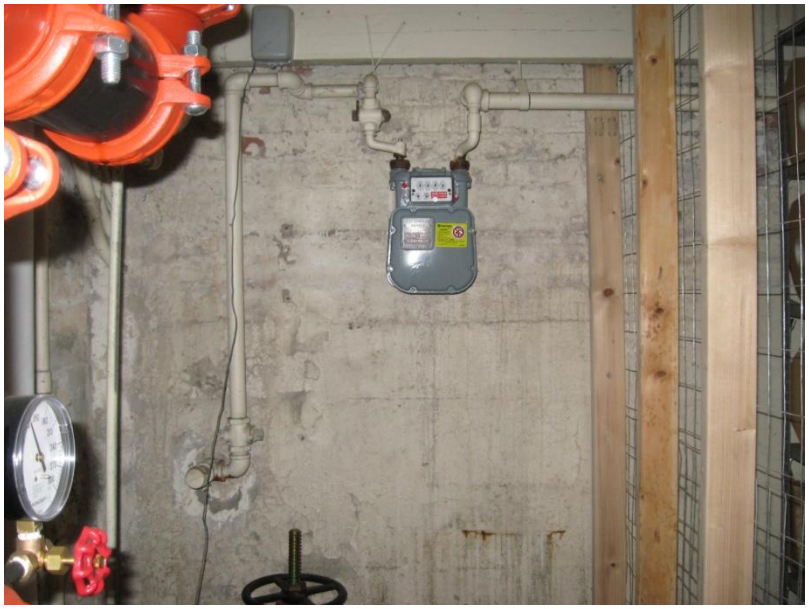
Alumni Gym
200 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 10010750023
Gas Meter Number: R000427
Physical Location: Rear of building

Atwater Kent
215 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant



NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422520016
Gas Meter Number: P012426
Physical Location: Mechanical Room

Bartlett Center
100 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

Boynton Hall
100 Institute Road

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

Campus Center
206 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 16647510011
Gas Meter Number: 6304899
Physical Location: Right side of building, outdoors

Collegiate Religious Center
19 Schussler Road

National Grid Account Number: 40089-90005
Electric Meter Number: 54134489
Meter Type: R-1
Physical Location: Rear, center of building

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 10547300011
Gas Meter Number: Q032477
Physical Location: Basement of building

20 Trowbridge
Previously Development and Alumni Relations

National Grid Account Number: 77476-73004 & 65016-57009
Electric Meter Number: 74800247 & 70767450
Meter Type: R-1 & R-1
Physical Location: Rear, Left of Building

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 10201180014
Gas Meter Number: P097289
Physical Location: Basement of building

Facilities (old)
27 Hackfeld Road

National Grid Account Number: 27629-33006
Electric Meter Number: 16421898
Meter Type: R-1
Physical Location: Left side of building, exterior

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 10201010013
Gas Meter Number: C657964
Physical Location: Basement of building

Fuller Labs
115 Salisbury Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

Goddard Hall
210 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422550013
Gas Meter Number: 9744018
Physical Location: Sprinkler Room, in Basement

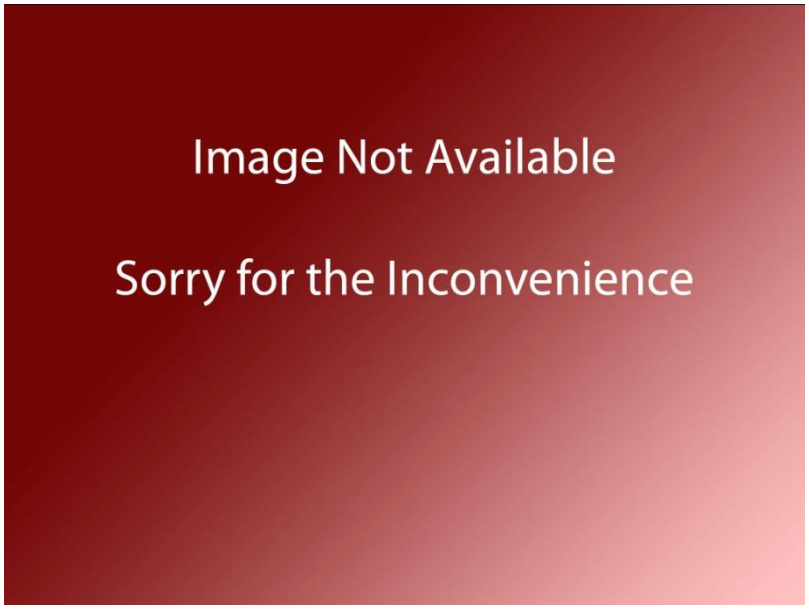
Gordon Library
209 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

Harrington Auditorium
204 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

Higgins House
1 John Wing Road



National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422600016
Gas Meter Number: 6276290
Physical Location: Basement of building

Higgins Labs
190 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422610015
Gas Meter Number: R000363
Physical Location: Between Higgins Labs and Alumni Gym (Wind Tunnel)

International House
28 Trowbridge Road

National Grid Account Number: 65016-55005
Electric Meter Number: 16071420
Meter Type: R-1
Physical Location: Rear, Left of Building

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 10201190013
Gas Meter Number: 0099343
Physical Location: Basement of Building

Kaven Hall
125 Salisbury Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422530015
Gas Meter Number: 0028699
Physical Location: Bad location (high off floor; inaccessible)

OASIS
20 Schussler Road

National Grid Account Number: 27629-17002
Electric Meter Number: 98732134
Meter Type: R-1
Physical Location: Rear of building; by staircase

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 27497550015
Gas Meter Number: P071524
Physical Location: Basement of building

Olin Hall
208 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422500018
Gas Meter Number: H387051
Physical Location: Sprinkler Room, Across from 014

Power House
187 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 27365800013
Gas Meter Number: X000190
Physical Location: Left side of Stratton Hall

Project Center
191 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422490012
Gas Meter Number: 6362420
Physical Location: Custodial Closet, near Men's Restroom

Salisbury Labs
201 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 16227730013
Gas Meter Number: P079304
Physical Location: Outside, next to emergency generator

Skull Tomb
44 Institute Road

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

Stratton Hall
185 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

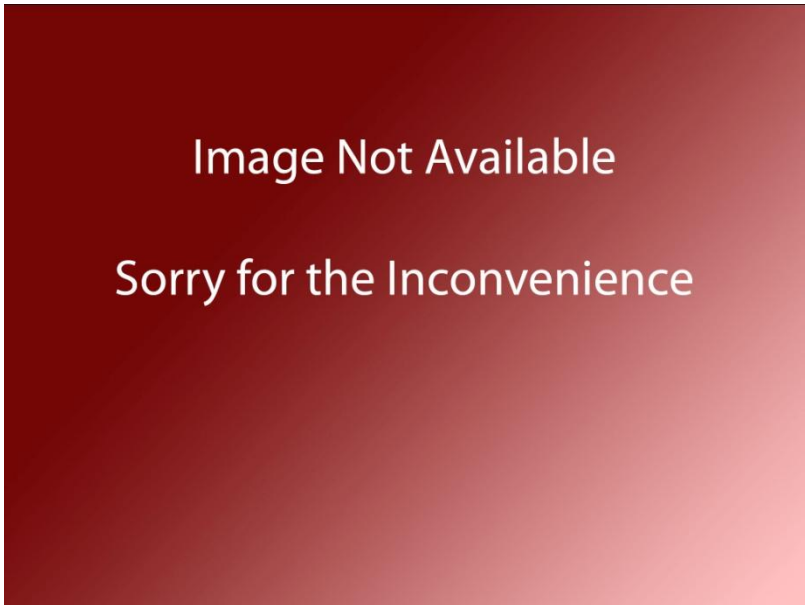
Student Development and Counseling Center (SDCC)
157 West Street

National Grid Account Number: 89946-46005
Electric Meter Number: 05091550
Meter Type: G-1
Physical Location: Rear, right of building

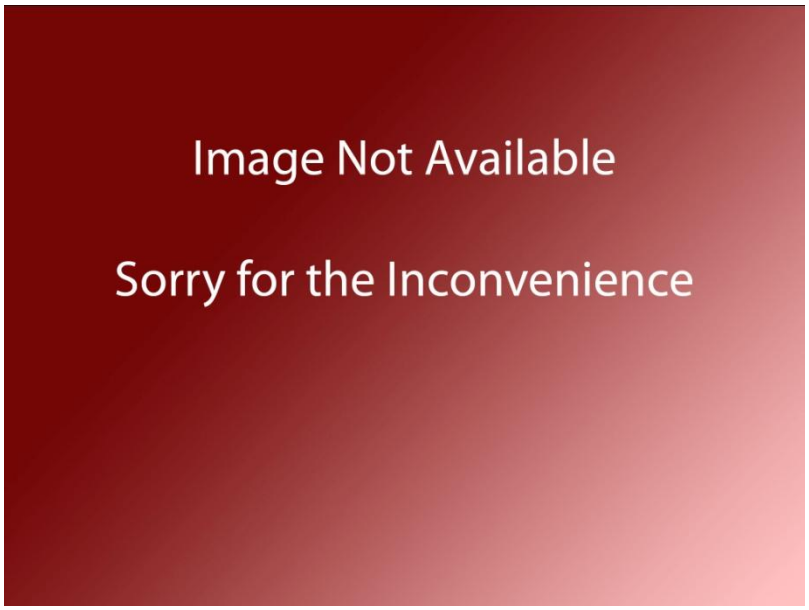
Washburn Shops
195 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

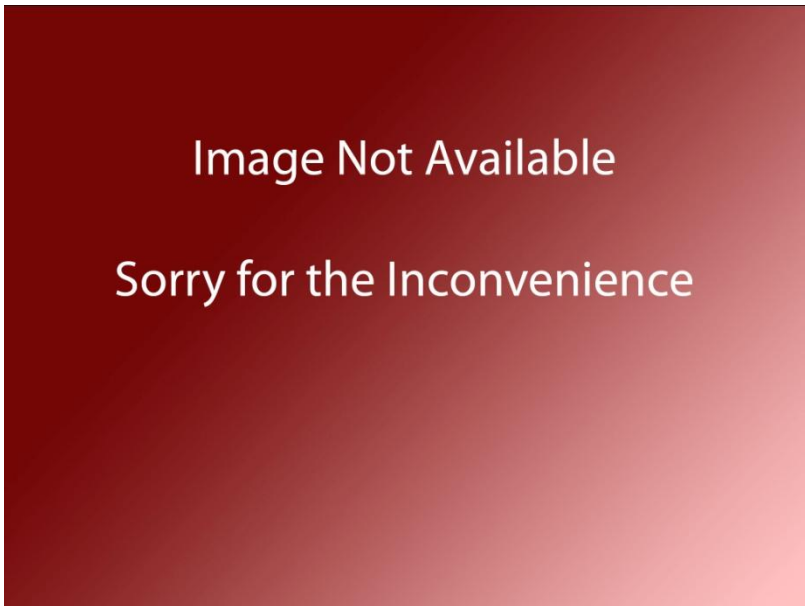
85 Prescott
Mass Academy, Development and Alumni Relatinons, Etc.



National Grid Account Number: 15233-01001
Electric Meter Number: 82829038
Meter Type: G-1
Physical Location: Information not available



National Grid Account Number: 97579-38005
Electric Meter Number: 02182894
Meter Type: G-2
Physical Location: Information not available



National Grid Account Number: 40129-20002
Electric Meter Number: 21050024

Meter Type: G-1
Physical Location: Information not available

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 26807200014
Gas Meter Number: 6288251
Physical Location: Back stairwell in Mass Academy; Off Physics Room

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 16631030042
Gas Meter Number: K186140
Physical Location: Back stairwell in Mass Academy; Off Physics Room

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28382030014
Gas Meter Number: Q021447
Physical Location: Back stairwell in Mass Academy; Off Physics Room

Gateway Park
60 Prescott Street

National Grid Account Number: 27672-37032
Electric Meter Number: 05798751
Meter Type: G-3
Physical Location: Right of Gateway building, across from Marriot Hotel

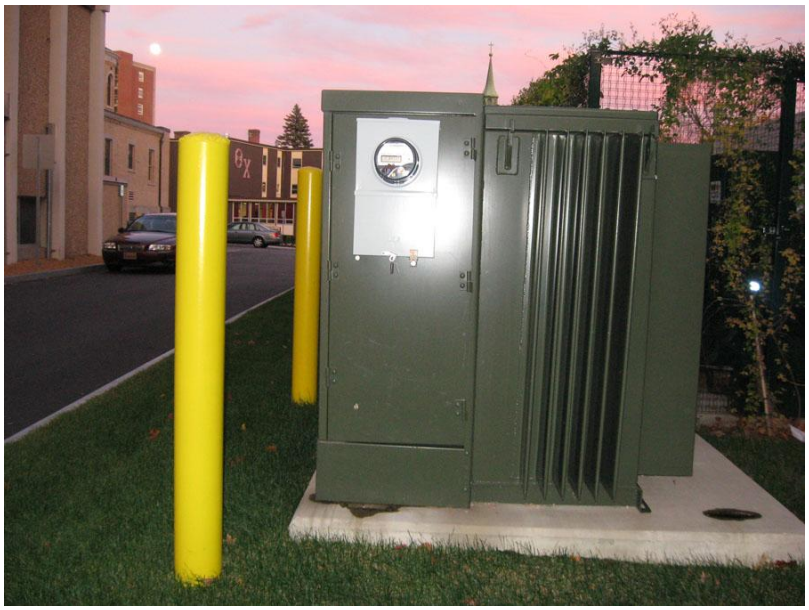
NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28003070035
Gas Meter Number: X000414
Physical Location: Right, Front of Building

Daniels
82 Institute Road

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422540014
Gas Meter Number: P092628
Physical Location: Sprinkler Room, Basement

East Hall
30 Boynton Street



National Grid Account Number: 91577-49006
Electric Meter Number: 05031049
Meter Type: G-3
Physical Location: Between East Hall and Armenian Church

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28177090025
Gas Meter Number: X000616
Physical Location: Left side of building

16 Elbridge Street

National Grid Account Number: 77476-58007
Electric Meter Number: 97560965
Meter Type: G-1
Physical Location: Right side of building, by staircase

NSTAR Account Number: 28382609999
NSTAR Statement Account Number:15971070014
Gas Meter Number: 0618023
Physical Location: Left side of building

Ellsworth Appartments
85 Institute Road

National Grid Account Number: 02841-83008
Electric Meter Number: 05030915
Meter Type: G-3
Physical Location: Across from 23 Einhorn; in Ellsworth Parking Lot

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 10202400015
Gas Meter Number: 6289916
Physical Location: Back corner of Ellsworth Parking Lot

Founders Hall
26 Boynton Street

National Grid Account Number: 27628-90015
Electric Meter Number: 05800149
Meter Type: G-2
Physical Location: Campus Police - Mechanical Room across from processing room

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422560012
Gas Meter Number: P040012
Physical Location: Rear of building

Fuller Apartments
79 Institute Road

National Grid Account Number: 89946-53000
Electric Meter Number: 05800681
Meter Type: G-3
Physical Location: Fuller Apartments parking lot; next to staircase

79 Institute Road

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 15764140016
Gas Meter Number: F668694
Physical Location: Left of F-18

81 Institute Road

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 15764150015

Gas Meter Number: C696555
Physical Location: Outside F-11

26 Hackfeld Road

National Grid Account Number: 27629-29002
Electric Meter Number: 54144272
Meter Type: R-1
Physical Location: Left side of building; exterior

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 10200990017

Gas Meter Number: Q023595
Physical Location: Basement of building

Institute Hall
12 Boynton Street

National Grid Account Number: 65016-38004
Electric Meter Number: 92667274
Meter Type: G-2
Physical Location: Institute Hall Parking Lot

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422620014
Gas Meter Number: 5481895
Physical Location: Basement; In Room 007, In closet 007A

Morgan Hall
90 Institute Road

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422460015
Gas Meter Number: 2015418
Physical Location: Across from Electric Room, Basement of Building

Sanford Riley Hall
74 Institute Road

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422510017
Gas Meter Number: 0525512
Physical Location: Mechanical Room, Across from B02/B03

22 Schussler Road

National Grid Account Number: 15193-52009
Electric Meter Number: 95430070
Meter Type: R-1
Physical Location: Rear, left of building

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 15959380013
Gas Meter Number: E227529
Physical Location: Basement of building

Stoddard A,B,C
95 Institute Road

National Grid Account Number: 15193-64036
Electric Meter Number: 05072249
Meter Type: G-3
Physical Location: Corner of Hackfeld Rd and Institute Rd

Stoddard A
23 Einhorn Road

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422630013
Gas Meter Number: 6274760
Physical Location: Left side, rear of building

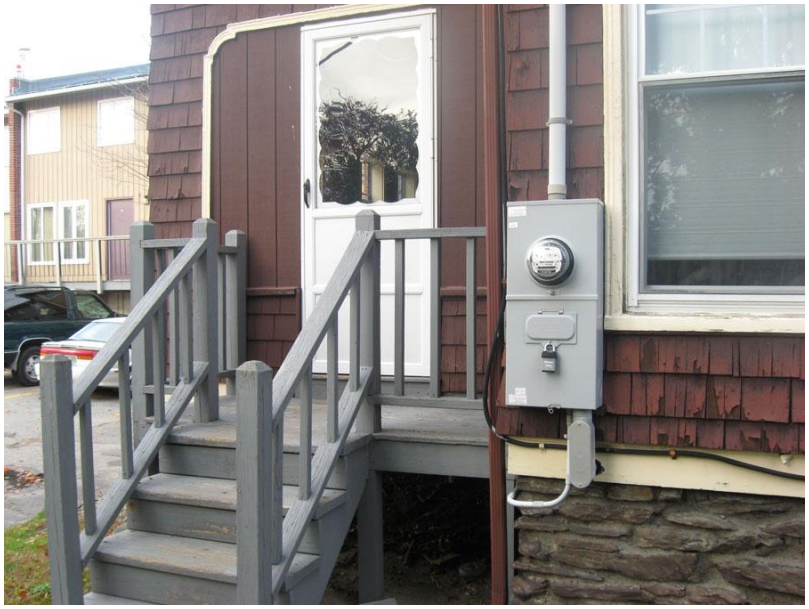
Stoddard B
95 Institute Road

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422640012
Gas Meter Number: 6390234
Physical Location: Across from Football Field, behind bush

Stoddard C (Includes Health Services)
32 Hackfeld Road

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 28422650011
Gas Meter Number: 6304895
Physical Location: Adjacent to Health Services

25 Trowbridge
Residence



National Grid Account Number: 89946-57008
Electric Meter Number: 15245026
Meter Type: R-1
Physical Location: Rear, Left of Building

Appendix F: List of Buildings on Primary Electric Meter

Buildings Receiving Electricity from:
Main Meter at 183 West Street (Power House)

- Alden Hall (Auditorium, Classrooms)
- Alumni Gym (Gym, Offices, Pool)
- Alumni Gym Extension (Locker Rooms, Offices)
- Atwater Kent (Classrooms, Labs)
- Bartlett Center (Admissions, Financial Aid)
- Boynton Hall (Offices, Administration)
- Campus Center (Offices, Meeting Rooms, Dining)
- Daniels Hall (Residence Halls, Offices)
- Fuller Labs (Classrooms, Auditorium)
- Goddard Hall (Classrooms, Labs, Offices)
- Gordon Library (Library, Meeting Rooms)
- Harrington Auditorium (Gymnasium, Classrooms)
- Higgins House (Offices, Food Service, Meeting Rooms)
- Higgins House Garage (Storage, Offices)
- Higgins Labs (Classrooms, Labs)
- Kaven Hall (Classrooms, Labs)
- Morgan Daniels Wedge (Meeting Rooms)
- Morgan Hall (Residence Hall, Offices, Food Service)
- Olin Hall (Classrooms)
- Powerhouse (Boiler Room)
- Project Center (Offices, Classrooms)
- Salisbury Labs (Classrooms, Labs)
- Sanford Riley Hall (Residence Hall, Administration)
- Skull Tomb (Meeting Place)
- Stratton Hall (Classrooms, Offices, Physical Plant Workshops, Storerooms)
- Washburn (Classrooms, Labs)
- Field House (Storage)
- Football Field Garage (Storage)
- Press Box / Bleachers (Press Box)

TOTAL: 29 Buildings / Properties

Appendix G: List of Off Campus Housing Owned by WPI

Provided by Amy Beth Polonsky, Assistant Director of Operations at Residential Services on 11/2/2009.

9 Boynton

11 Einhorn

15 Einhorn

16 Einhorn

17 Einhorn

2 Elbridge

8 Elbridge

10 Elbridge

20 Elbridge

30 Elbridge

8 Hackfeld

10 Hackfeld

11 Hackfeld

12 Hackfeld

18 Hackfeld

23 Hackfeld

24 Hackfeld

47 Institute

49 Institute

13 Schussler

15 Schussler

17 Schussler

53 Wachusett

67 Wachusett

Appendix H: Street Addresses of Owned WPI Property

Also obtained from Amy Beth Polonsky

Alden Hall	172 West Street
Alumni Gym	200 West Street
Atwater Kent	215 West Street
Bartlett Center	100 Institute Road (West Street)
Boynton Hall	100 Institute Road
Campus Center	206 West Street
Daniels Hall	82 Institute Road
East Hall	30 Boynton Street
East Hall Garage	37 Dean Street
Ellsworth No. 1	91 Institute Road
Ellsworth No. 2	89 Institute Road
Ellsworth No. 3	85 Institute Road
Founder's Hall	26 Boynton Street
Fuller Labs	115 Salisbury Street
Fuller No. 4	81 Institute Road
Fuller No. 5	79 Institute Road
Goddard Hall	210 West Street
Gordon Library	209 West Street
Harrington Auditorium	204 West Street
Higgins House	John Wing Road
Higgins Labs	190 West Street
Institute Hall	12 Boynton Street
Kaven Hall	125 Salisbury Street
Lee Street School Bldg.	37 Lee Street (future home of Facilities Department)
Mass Academy	85 Prescott Street
Morgan Hall	90 Institute Road
Olin Hall	208 West Street
Powerhouse	187 West Street
Project Center	191 West Street
Riley Hall	74 Institute Road
Salisbury Labs	201 West Street
Skull tomb	44 Institute Road
Stoddard A	23 Einhorn road
Stoddard B	95 Institute Road
Stoddard B	32 Hackfeld Road
Stratton Hall	185 West Street
Washburn Shops	195 West Street

Appendix I: Sustainability Questions

Frank Horanzy – Electricity and Sustainability on WPI

- What is your position and what do you mainly work with?
- How long have you been at WPI?
- What are some ways that you've helped to make WPI more sustainable?
- Has this increased in the recent years?
- Do you get to propose suggestions, or does someone else figure out ways to save money?
- What are some current green/sustainable projects going on currently?
- Is there anything planned for the near future?
- Are you doing anything with the new proposed athletic center?
- If you were able to see the power consumption levels on a day-to-day, even hourly, basis, how would it affect your work?
- Are there any examples of problems with buildings that weren't detected until they caused visible damage?
- Is there any easy way for you to track when the campus goes into peak voltage or if a building has surges?

Chris Salter – E-Mon D-Mon Meters

- What is your position and what do you mainly work with?
- What was the need for these additional meters?
- Where are they located?
- Have they been installed yet?
- Are there plans to expand the meters to other parts on campus?
- If so, to what buildings? Ones with meters currently or ones on the main feed?
- What do you hope the new meters will help with?
- We saw on the company website, that they can be network ready, do these have those features?
- It seems like we could use these meters to have a online tracking system like at Clark University and other colleges. Is this a possibility for the future?
- We've been looking into a group that tracks on a minute to minute basis and has visual displays for the community, and can possibly use these meters – is it possible to get a spec sheet or part number of the meter?
- How much do the meters cost each to install, and if they work out what is the plan to add more to campus?
- Do you have any other plans to increase better utilities metering or increase sustainability on campus?

Liz Tomaszewski– Recyclemania and Green Team

- What is your position and what do you mainly work with?
- How long have you been at WPI?
- What are some ways that you've helped to make WPI more sustainable?
- Has this increased in the recent years?
- How long has Recyclemania gone on, and what are the overall results from them?

- We've been looking into a system that would let us see energy consumptions on a minute to minute basis, would this be useful in promoting awareness for your position? (i.e. more competitions, etc)
- What current and recent plans are there to increase sustainability on campus?
- What are any future projects to increase sustainability, particularly with buildings like East Hall and the new Athletics center?
- What do you know about LEAD certification, and what are some ways WPI has tried to reach it?
- If we had metering of buildings, how would that help you in increasing sustainability on campus?

Norman Hutchins from HVAC – Air Conditioning, Heating, and Timing

- What is your position and what do you mainly work with?
- How long have you been at WPI?
- What are some ways that you've helped to make WPI more sustainable?
- Has this increased in the recent years?
- How does air conditioning and heating work on campus?
    - How is everything timed and scheduled to go off?
    - Is it the same every day, or is it programmed to be different on days like the weekend
    - How is it during breaks and summer time?
    - Consistent for every building, or does it vary?
- Are there any cases of problems that weren't detected until they caused more visible damage?
- What are some current or recent projects you have worked on to help save energy and make things more efficient?
- What are some future projects that you guys have in mind?
- If you had a way to see the energy consumptions of buildings on a hourly basis, how would this affect your work?

Appendix J: Frank Horanzy Meeting Notes

- Lead Electrician
- At WPI for 22 years
- Has worked with fire alarms, lightbulbs for sustainability projects
- Library
    - lights never shut off
    - controls messed up
- Motion sensors
    - save moneys
    - new buildings (east, gateway)
    - hallways in daniels/Morgan
    - classrooms have nothing
        - depends on technical stuff too (projectors, tv's, etc)
    - Bathrooms have it (installed 12-15 years ago)
- Lack of Motion Sensors
    - Higgins labs in offices, teacher refusing to move coat rack
    - People in Gateway not being active enough
        - Not enough sensors in there
        - Same problem with East Hall
    - Convinence vs being green
    - Real numbers of savings
- Heating
    - 68 to 69 day
    - 62 to 64 night
    - 350 days
    - AC control in SL 315/402
        - Some time, some motion
    - Start with assuming a 12 hour occupation, then cut down
- Gut job to redo lighting properly
    - too much hassle to edit rooms one by one
    - do when buildings are getting renovated
- Large investment for the controls/green, not much return for certain things
- Move to Lee Street costing 60 hours a week for some
- Salisbury labs
    - 3rd/4th = motion sensors
    - Bad design – not changing lighting in renovations
    - Transformer blowing up
- Tracking --- no monitoring, energy management
- 15 years ago – T12 to t8's for lightbulbs
- 5 gallon toilets
- Motors = speed controls, everywhere
- Weren't reliable in the past for metering; if you had it, it could help, but lots of money to spend before

- Rec center – nightmare,
- Goddard – weird lighting, ballasts
- East hall - T5's;
    - don't last
    - burn fast on the ends (hotter)
    - burns sockets
    - pain to reach and input
- Ballasts – 80 vs 20 ,more expensive
    - Library – 200 ballasts
- Fuller – chillers need some fixes

Appendix K: Chris Salter + Norman Hutchins Meeting Notes

- AC
    - East Hall
    - Gateway
    - Goddard
    - Atwater Kent – installed in the 80's
    - Salisbury wing built in the 80's
- 1960's
    - No one on campus in the summer
    - No need for air conditioning
- 70's/80's
    - Need for air conditioning rises
- Windowed Uints
    - Very inefficient
    - Cheaper than installing for the building
- Alden Memorial – added in 00's, renovations in 90s
- Res Hall Competition
    - Combined – offices and dining halls
    - Almost down to indentifying circuits (Morgan/Daniels)
    - Hard to make fully accurate
- New Meters
    - Morgan/Daniels
        - Daniels basement
        - 12208
        - One set of current
        - Meter mains and service lateral
    - Riley
        - 12208
        - Low voltage
        - Fed from alden
        - Theater and Riley Commons
    - Fuller
        - Not installed yet
        - Electric/heat
        - Lighting
        - Mechanical
- Daniels is up, not transmitting, firewall problems?
- Lot of effort in past few years
- Aware of discrete metering for a long time
- Needed seed money, could do about 2 buildings a meter
- Schneider and Andover – 80%
- Automated Logic – 20%
- European Software, wanted to selling you hardware, tie you into 5k – 7k a year

- E-Mon
    - Pennsylvania
    - Ladnloards
    - Simple
    - Steam, water, etc
    - More sustainability, don't submeter
- Next Steps
    - Evolve system
    - 5 year plan
    - No funding in '10, '11
    - 7-8k down to 5-6k a meter for installation
- Norman
    - Troubleshooting
    - Have had troubles with getting new meters working
- Public Relations
    - Export data
    - Where? How?
    - Hard to maintain continuity
    - Hard for facilities – more responsibilities
    - 8 year solar panel on Morgan Daniels
        - Barely used
        - Barely sustained
        - Saved about 22 cents once
- Gateway
    - Some lighting control -> cut out of final plans
    - Valve engineering

Appendix L: Lucid Design Group

Questions for Conference Call

Lucid Design Questions

1.) What exactly does your company do?
2.) What different types of services/products can you offer to WPI to help with its utilities management?
3.) Are there any "minimum" requirements needed for our current metering system before yours is put in place?
4.) What would the estimated price be for such services?
5.) How long have you been offering these products to companies to help manage their utilities usage?
6.) Who are some of your other clients?
7.) How has the feedback from them been?
8.) Do you have any plans for adding new features/services in the future?
9.) How long would it take to implement?
10.) And is it possible to implement in stages?
11.) Is it possible to integrate your services with other existing meter technologies, such as Emon Demon?
12.) Does the software have the capability to show savings over time (trend analysis)?
13.) Do you offer any special services for LEED certified buildings (East Hall)?

Conference Call Notes

Lucid Design Interview / Teleconference
2/3/2010

- Kai Mak (contact at Lucid Design group –Sales)
- Lucid Design Group
  - Been in business for 6 years
  - 100 customers
- Dashboard Starter kit
  - 2 meters
- Colors, logos, and text on dashboard are all customizable by the client
- Performance
  - Google gadgets
  - Can put on sustainability website
- Unit equivalent
  - Uses common items / equivalences to keep the act of thinking green interesting for the students who might not care about kwh
- Data downloader
  - Download data in Excel format
  - Perform trends analysis
- Can be implemented in stages
- Competitions

    - Engage the students
    - Helps the university financially and with its green-image
    - “Do it in the dark hour”
- Green tips module
- Weather module
- Events
    - Syncs with a Google calendar (Green events, competitions, etc)
- Renewables (solar, wind, etc)
- Green features
    - LEED certification (+2 points)
- Information from meters to server:
    - Data loggers
        - MAC addresses
        - Static/dynamic IP addresses
    - Output/Modbus pulse
    - Totalizer
- Roughly $25,000 for 8 buildings (electricity only)
- Roughly $2,000 per year for maintenance

Appendix M: Sample Bills

Gas Bill

NSTAR

Post Office Box 4508
Woburn, MA 01888-4508

Account Number
21 30 2838 260 9999 H

WPI-NEWGATE PROP
OFC OF FACILITIES
100 INSTITUTE RD
WORCHESTER MA 01609-2247

NSTAR Gas

This Detail Bill Is for Your Records Only. Do Not Use this Stub for Payment.

RETURN THIS PORTION WITH YOUR PAYMENT. MOVING? PLEASE LET US KNOW, OTHERWISE YOU MAY BE RESPONSIBLE FOR ENERGY USE AFTER YOU MOVE.

Account Number	Billing Date	Next Read Date
2800 307 0035	Jul 2, 2009	Aug 1, 2009

Service Provided to

WPI-NEWGATE PROP
68 PRESCOTT ST
WORCESTER MA 01605

Account Summary

Previous Bill	2,353.30
Payment - Thank You	-1,605.88
Delivery Charges Total	750.71
Delivery Chgs Balance	**$1,498.13**

Gas Used

Rate 67-Commercial Heating
Meter X000414

Jun 30, 2009 Actual Read		75643
Jun 01, 2009 Actual Read	-	63823
CCF Used in 29 Days		11820
Times Therm Factor	X	1.0279
Therms Billed this Meter		12150

Date	Therms
06/30	12150
06/01	14349
04/30	12875
04/01	16064
03/01	17317
02/01	24188
12/31*	19982
12/01	16332
11/01	8573
10/14	13112
09/15	15382
08/13	11740
07/18	12329
06/17	14051

*Estimate

Charges for Gas Used

Delivery Charges

Customer Charge				100.19
Distrib Demand 1.07	X	625	Therms	668.75
Distrib Adj - .00150	X	12150	Therms	-18.23
Delivery Charges Total				**750.71**

NSTAR CUSTOMER SERVICE CENTER 800.592.2000

Electric Bills

nationalgrid

www.nationalgrid.com

WPI PLANT SERVICES
MAIN CAMPUS POWER
183 WEST ST
WORCESTER MA 01609

Jun 18, 2009 to Jul 21, 2009

ACCOUNT NUMBER	PLEASE PAY BY	AMOUNT
27644-44020	Aug 15, 2009	$ 41,881.

CUSTOMER SERVICE
1-800-322-3223

CREDIT DEPARTMENT
1-888-211-1313

POWER OUTAGE OR DOWNED LINE
1-800-465-1212

EMAIL BILLING INQUIRES
customerservice@us.ngrid.com

ADDRESS
PO Box 960
Northborough, MA 01532-0960

DATE BILL ISSUED
Jul 22, 2009

ACCOUNT BALANCE

Previous Balance		36,737.
Payment Received on JUL 6 (*Check*)	*THANK YOU*	- 36,737.
Current Charges		+ 41,881.
	Amount Due Now ▶	$ 41,881.

To avoid late payment charges of 0.95%, your "Amount Due Now" must be received by Aug 15 2009.

Our records indicate that you have switched your supplier option to Direct Energy Business, LLC Supplier. If you have been switched without your authorization, a formal complaint can be filed with the Department of Public Utilities.

DETAIL OF CURRENT CHARGES

Delivery Services

Type of Service	Current Reading	-	Previous Reading	=	Difference	x	Meter Multiplier	=	Total Usag
Energy	32752 *Actual*		32141 *Actual*		611		2400		1466400 kWh
Peak	15071 *Actual*		14789 *Actual*		282		2400		676800 kWh
Off Peak	17681 *Actual*		17352 *Actual*		329		2400		789600 kWh
								Total Energy	1466400 kWh

Demand-kW		
Peak	2400	3048.0 kW
Off Peak	2400	2520.0 kW
Demand-kVA		
Peak	2400	3504.0 kVA
Off Peak	2400	2928.0 kVA

METER NUMBER 04848559 NEXT SCHEDULED READ DATE Aug 18
SERVICE PERIOD Jun 18 - Jul 21 NUMBER OF DAYS IN PERIOD 33
RATE Time-of-Use G-3 VOLTAGE DELIVERY LEVEL 2.2 - 15 kv

Enrollment Information

To enroll with a supplier or change to another supplier, you will need the following information about your account:
Loadzone WCMA
Acct No: 27644-44020 Cycle: 14, WPI

Electric Usage History

Month	kWh	Month	kWh
Aug 08	470400	Mar 09	1320000
Sep 08	1663200	Apr 09	1562400
Oct 08	1483200	May 09	1286400
Nov 08	1533600	Jun 09	1312800
Dec 08	1372800	Jul 09	1466400
Jan 09	1310400		
Feb 09	1358400		

Billed Demand Last 12 months

Minimum	2635.2
Maximum	3844.8
Average	3084.6

KEEP THIS PORTION FOR YOUR RECORDS

RETURN THIS PORTION WITH YOUR PAYMENT

nationalgrid

ACCOUNT NUMBER	PLEASE PAY BY	AMOUNT DUE
27644-44020	Aug 15, 2009	$ 41,881.84

PO Box 960
Northborough MA 01532-0960

ENTER AMOUNT ENCLOSED
$

Write account number on check and make payable to National Grid

*****AUTO**5-DIGIT 01609
WPI PLANT SERVICES
MAIN CAMPUS POWER
183 WEST ST
WORCESTER MA 01609-2253

05859

NATIONAL GRID
PO BOX 1005
WOBURN MA 01807-1005

004188184 27644402070041881842 27

nationalgrid

WPI PLANT SERVICES
MAIN CAMPUS POWER
183 WEST ST
WORCESTER MA 01609

Jun 18, 2009 to Jul 21, 2009

ACCOUNT NUMBER	PLEASE PAY BY	AMOUNT DUE
27644-44020	Aug 15, 2009	$ 41,881.84

Customer Charge		73.16
Dist Chg On Peak	0.01229 x 676800 kWh	8,317.87
Dist Chg Off Peak	-0.00045 x 789600 kWh	-355.31
Transition Charge	0.00061 x 1466400 kWh	894.50
Transmission Charge	0.01192 x 1466400 kWh	17,479.49
Distribution Demand Chg	3.92 x 3153.6 kW/kVA	12,362.11
High Voltage Discount	-0.46 x 3153.6 kW	-1,450.66
Dem Side Mgmt Chg	0.0025 x 1466400 kWh	3,666.00
Transition Demand Chg	0.19 x 3153.6 kW	599.18
Renewable Energy Chg	0.0005 x 1466400 kWh	733.20
High Voltage Metering	-1.0 % x $ 43770.20	-437.70
	Total Delivery Services	**$ 41,881.84**

Explanation of General Billing Terms

KWH: Kilowatt-hour, a basic unit of electricity used.
Off-Peak: Period of time when the need or demand for electricity on the Company's system is low, such as late evenings, weekends and holidays.
Peak: Period of time when the need or demand for electricity on the Company's system is high, normally during the day, Monday through Friday, excluding holidays.
Estimated Bill: A bill which is calculated based on your typical monthly usage rather than on an actual meter reading. It is usually rendered when we are unable to read your meter.
Meter Multiplier: A number by which the usage on certain meters must be multiplied by to obtain the total usage.
Demand Charge: The cost of providing electrical transmission and distribution equipment to accommodate your largest electrical load.

Supplier Service Charges are comprised of:

Generation Charge: The charge(s) to provide electricity and other services to the customer by a supplier.

Delivery Service Charges are comprised of:

Customer Charge: The cost of providing customer related service such as metering, meter reading and billing. These fixed costs are unaffected by the actual amount of electricity you use.
Distribution Charge: The cost of delivering electricity from the beginning of the Company's distribution system to your home or business.
Transition Charge: Company payments to its wholesale supplier for terminating its wholesale arrangements.
Transmission Charge: The cost of delivering electricity from the generation company to the beginning of the Company's distribution system.

Demand Side Management: The cost of demand side management programs offered by the Company.
Renewable Energy Charge: A charge to fund initiatives for communicating the benefits of renewable energy and fostering formation, growth, expansion and retention of renewable energy and related enterprises.

Questions:
If you have questions or complaints regarding this bill or National Grid's service quality, please contact Customer Service at 1-800-322-3223. You may also contact the Massachusetts Department of Public Utilities, Consumer Division at 617-305-3531 or toll free at 1-800-392-6066 or web site www.mass.gov/dpu.

Direct Energy Business

WORCESTER POLYTECHNIC INSTITUTE
OFFICE OF FACILITIES 100 INSTITUTE RD
WORCESTER, MA 01609

Account Number: 1061578
Invoice Number: 92610008075184
Billing Date: September 18, 2009
Page 1

Questions about your bill? Contact Direct Energy Business Customer Relations at CustomerRelations@DirectEnergy.com, or call us at 1-888-925-9115.

Congestion-related charges associated with accounts may be passed-through as per Paragraph 7 ("Price") of the Agreement with Direct Energy Business. Any noted congestion charge on your monthly bill is ESTIMATED and will be subject to an adjustment to reflect actual congestion charges.

In the event that the Term of your Agreement has expired, your account will be invoiced at a Market Based Rate or MCPE rate. Please refer to your agreement for additional information.

ACCOUNT SUMMARY INFORMATION

Previous Balance	$0.00
Payment Received	$0.00
Adjustments	$0.00
Total Balance Forward	$0.00
Current Usage Charges	$112,997.64
Total Current Charges	$112,997.64
Total Amount Due	**$112,997.64**

COPY

11001-4660-7434

Detach here and return this portion with check or money order. Do not staple or fold.

Direct Energy Business

Account Number	**1061578**
Due Date	**October 8, 2009**
Total Due	**$112,997.64**
Amount Enclosed	$ 112,997.64

Please write your account number on your check or money order made payable to Direct Energy Business.

WORCESTER POLYTECHNIC INSTITUTE
OFFICE OF FACILITIES 100 INSTITUTE RD
WORCESTER, MA 01609

5000000000000000106157820091008001129976 4

Direct Energy Business

COPY

Account Number: 1061578
Invoice Number: 92610008075184
Billing Date: September 18, 2009

YOUR SERVICE CHARGES

183 WEST ST, WORCESTER MA
EDC.# 2764444020 **Store Number :**

Direct Energy Business
Electric Service

Meter#

Service Period July 21, 2009 to August 17, 2009 Actual-Total	3,284.45 kW UCAP
Meter Multiplier of	

Meter# UNKNOWN

Service Period July 21, 2009 to August 17, 2009 Actual-Total	1,428,000 kWh
Meter Multiplier of	

July 21, 2009 to August 17, 2009

Fixed Price - 1,428,000 kWh Total @ $0.07913/kWh	$112,997.64
Current Actual Charges	$112,997.6

TOTAL CHARGES FOR EDC.# 2764444020 **$112,997.6**

Direct Energy Business

WORCESTER POLYTECHNIC INSTITUTE
OFFICE OF FACILITIES 100 INSTITUTE RD
WORCESTER, MA 01609

Account Number: 1061577
Invoice Number: 92610008075183
Billing Date: September 18, 2009

Questions about your bill? Contact Direct Energy Business Customer Relations at CustomerRelations@DirectEnergy.com, or call us at 1-888-925-9115.

Congestion-related charges associated with accounts may be passed-through as per Paragraph 7 ("Price") of the Agreement with Direct Energy Business. Any noted congestion charge on your monthly bill is ESTIMATED and will be subject to an adjustment to reflect actual congestion charges.

In the event that the Term of your Agreement has expired, your account will be invoiced at a Market Based Rate or MCPE rate. Please refer to your agreement for additional information.

ACCOUNT SUMMARY INFORMATION

Previous Balance	$0.00
Payment Received	$0.00
Adjustments	$0.00
Total Balance Forward	$0.00
Current Usage Charges	$37,175.27
Total Current Charges	$37,175.27

COPY

Total Amount Due **$37,175.27**

11001-4690 - 7434

Detach here and return this portion with check or money order. Do not staple or fold.

Direct Energy Business

Account Number	**1061577**
Due Date	**October 8, 2009**
Total Due	**$37,175.27**
Amount Enclosed	$ 37,175.27

Please write your account number on your check or money order made payable to Direct Energy Business.

WORCESTER POLYTECHNIC INSTITUTE
OFFICE OF FACILITIES 100 INSTITUTE RD
WORCESTER, MA 01609

5000000000000000106157720091008000371752 7

Direct Energy Business

COPY

Account Number: 1061577
Invoice Number: 92610008075183
Billing Date: September 18, 2009

YOUR SERVICE CHARGES

60 PRESCOTT ST, WORCESTER MA
EDC.# 2767235032 **Store Number :**

Direct Energy Business
Electric Service
Meter#

Service Period July 22, 2009 to August 17, 2009 Actual-Total	978.52	kW UCAP
Meter Multiplier of		
Meter# UNKNOWN		
Service Period July 22, 2009 to August 17, 2009 Actual-Total	469,800	kWh
Meter Multiplier of		
July 22, 2009 to August 17, 2009		
Fixed Price - 469,800 kWh Total @ $0.07913/kWh	$37,175.27	
Current Actual Charges		$37,175.2

TOTAL CHARGES FOR EDC.# 2767235032 **$37,175.2**

101209 000026423 2 0000629146 000265877

Direct Energy
Business

Account Number:	Invoice Number:	Invoice Date:	Due Date:
26423	629146	09/21/2009	10/12/2009

Amount Now Due: **$2,658.**

Amount Enclosed: $ 2 6 5 8 7

WORCESTER POLYTECHNIC INSTITUTE
OFFICE OF FACILITIES
100 INSTITUTE RD
WORCESTER, MA 01609

COPY

Send Payment To:
Direct Energy Services, LLC
P.O. Box 1564
New York, NY, 10008-1564

☐ Change of Address

***Include Your Account & Invoice Number On The Che**

Please detach and return this stub with your check payable to "Direct Energy Services, LLC". Thank You.

Customer Service Information

Questions about your bill?

Call: 1-888-925-9115
Email: CustomerRelations@directenergy.com
Internet: www.DirectEnergy.com

Write to:
Customer Relations Manager
Two Gateway Center
Pittsburgh, PA, 15222

11001-4660-7434

Account Number:	264
Invoice Number:	6291
Invoice Date:	09/21/20(
Amount Due:	$2,658.7

Summary of Charges/Credits

Prior Balance	$1,329.3
Payment Received on 09/11/2009	($1,329.3
Current Charges	$2,658.7
Amount Due:	**$2,658.7**

Service Information

Mailing Address:	Service Address:	Account Information:	
WORCESTER POLYTECHNIC INSTITUTE OFFICE OF FACILITIES 100 INSTITUTE RD WORCESTER, MA 01609	WORCESTER POLYTECHNIC INSTITUTE 95 Institute Rd Worcester, MA 01609	**Commodity:** **Utility Account:** **Utility Name:** **Emergency Phone #:**	Electricity 1519364036 Massachusetts Electric 800-867-5222

Detail Information

Product: Fixed Price

Congestion Zone: MECO WCMASS

Billing Period: 08/17/2009 - 09/18/2009 **Total Usage:** 33,600 KWh

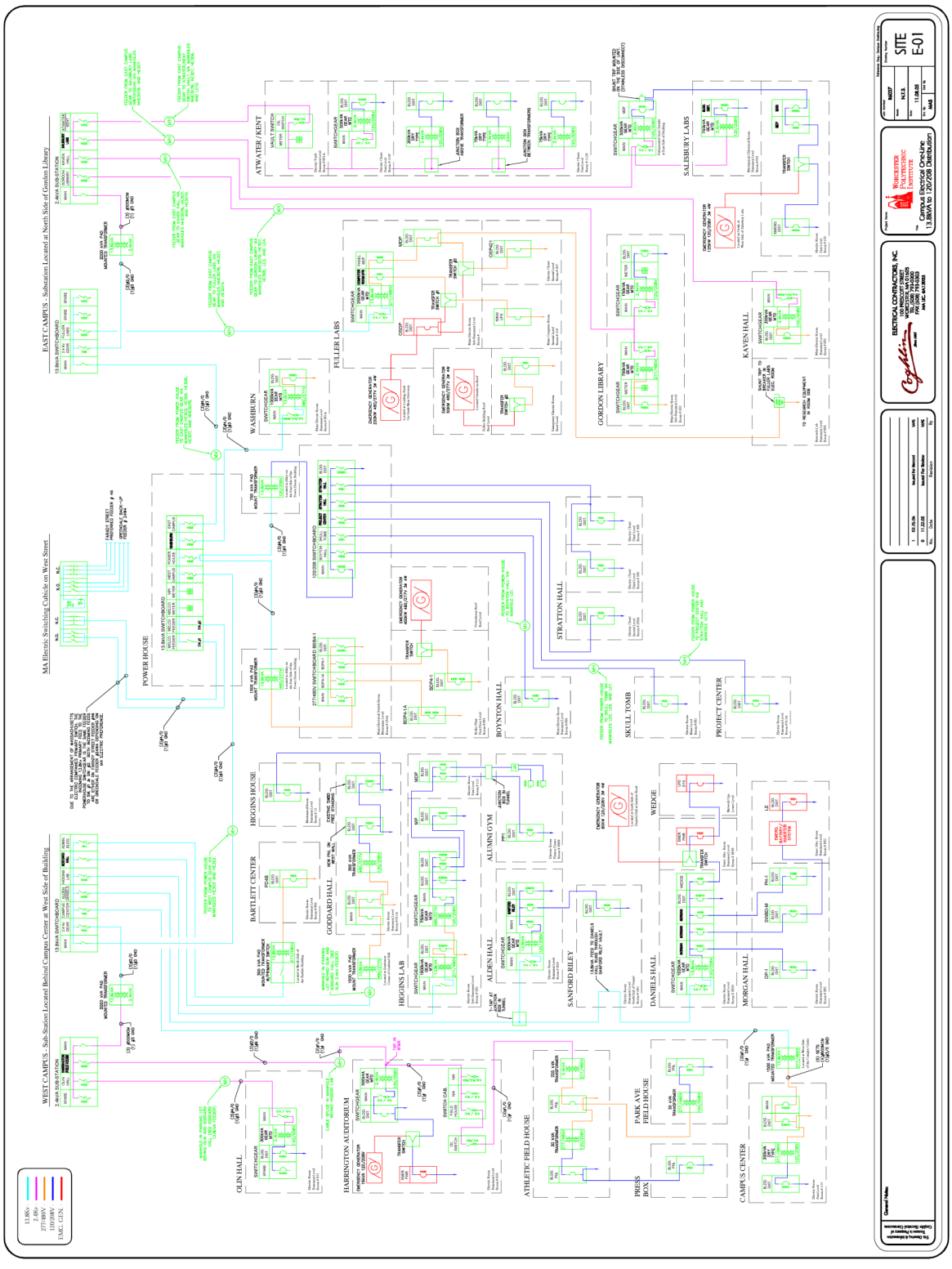
Charges	Unit	Volume	Unit Price	Percentage	Amour
Fixed Price	KWh	33,600.00	$0.07913		$2,658.7
Total Charges					$2,658.7

Current Charge Total: **$2,658.77**

Page: 1 of 1

Direct Energy

Appendix N: Main Electrical Distribution Map



Appendix O: Meter Walk Around Problems

- 26 Boynton St Pole MH338 (mech room)
  - 2nd inactive meter
  - Possibly has to do with backup generator
  - ID: 76687125
- Fuller Apts Parking Lot (G3) pic:22
  - Meter #: 5800681
  - No corresponding bill
- Pictures 18 and 19 show old panel in laundry room at Ellsworth/Fuller Apts
- Pictures 23-27 show two electrical rooms replaced by new G3 meter
- Garage at 23 Trowbridge
  - Meter we are not being billed for
  - Meter #: 5117095
- 2 Elbridge St Apt 2
  - 2nd meter, no corresponding bill
  - Meter #: 60070290
- 20 Elbridge St
  - Unknown 4th meter
    - Fed apt 2
  - Meter #: 75381147
- 35 Institute Rd
  - House says 37 Institute Rd
- 70 Park Ave became 75 Park Ave (same meter)
- 60 Prescott – Gateway garage
  - New meter
  - Supposed to pay??
  - Meter #: 98726143
  - Picture 50
- 13 Schussler Rd
  - Meter #: 66175724
  - Not included in last billing cycle
    - 9/17/09 – 10/19/09
- 15 Schussler Rd
  - Back center
  - WPI pay for??
  - Meter #: 66175724
  - Pic 28

- 152 West St Pole 5
  - 152 West is an apt building not owned by WPI
    - Next to parking lot

Appendix P: Proposed Meter Map

Mock Meter Map

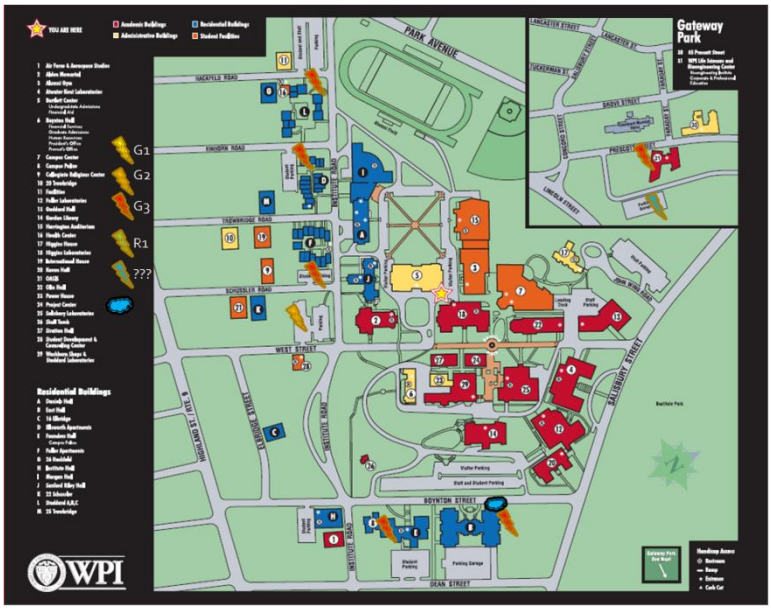


Figure 10. Overview of WPI

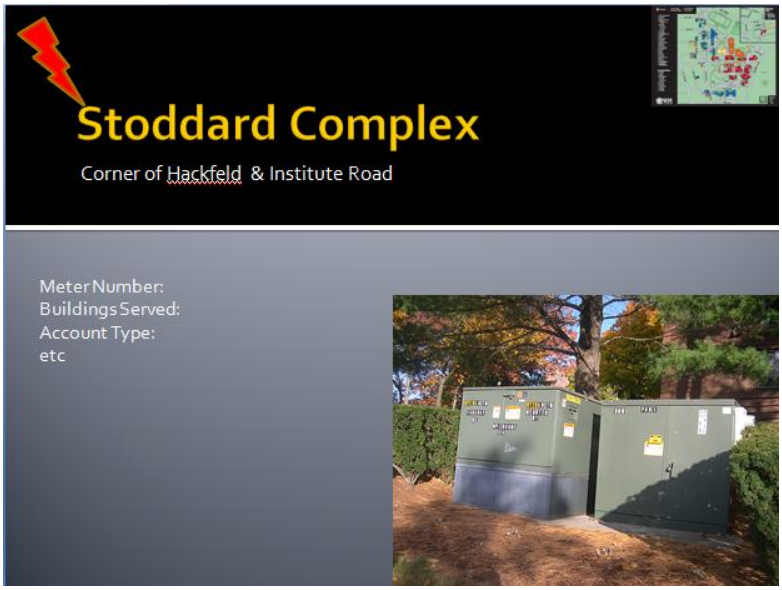
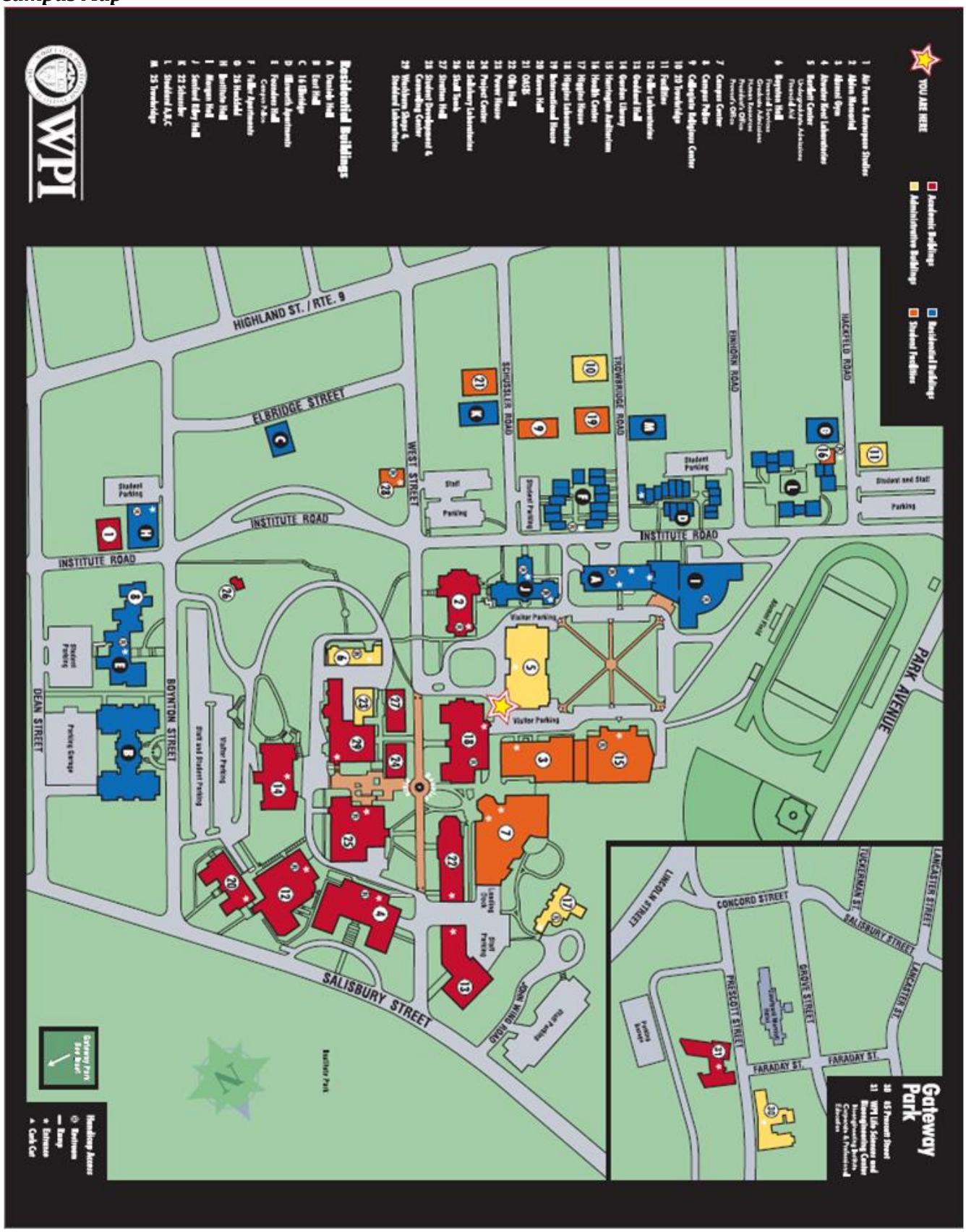
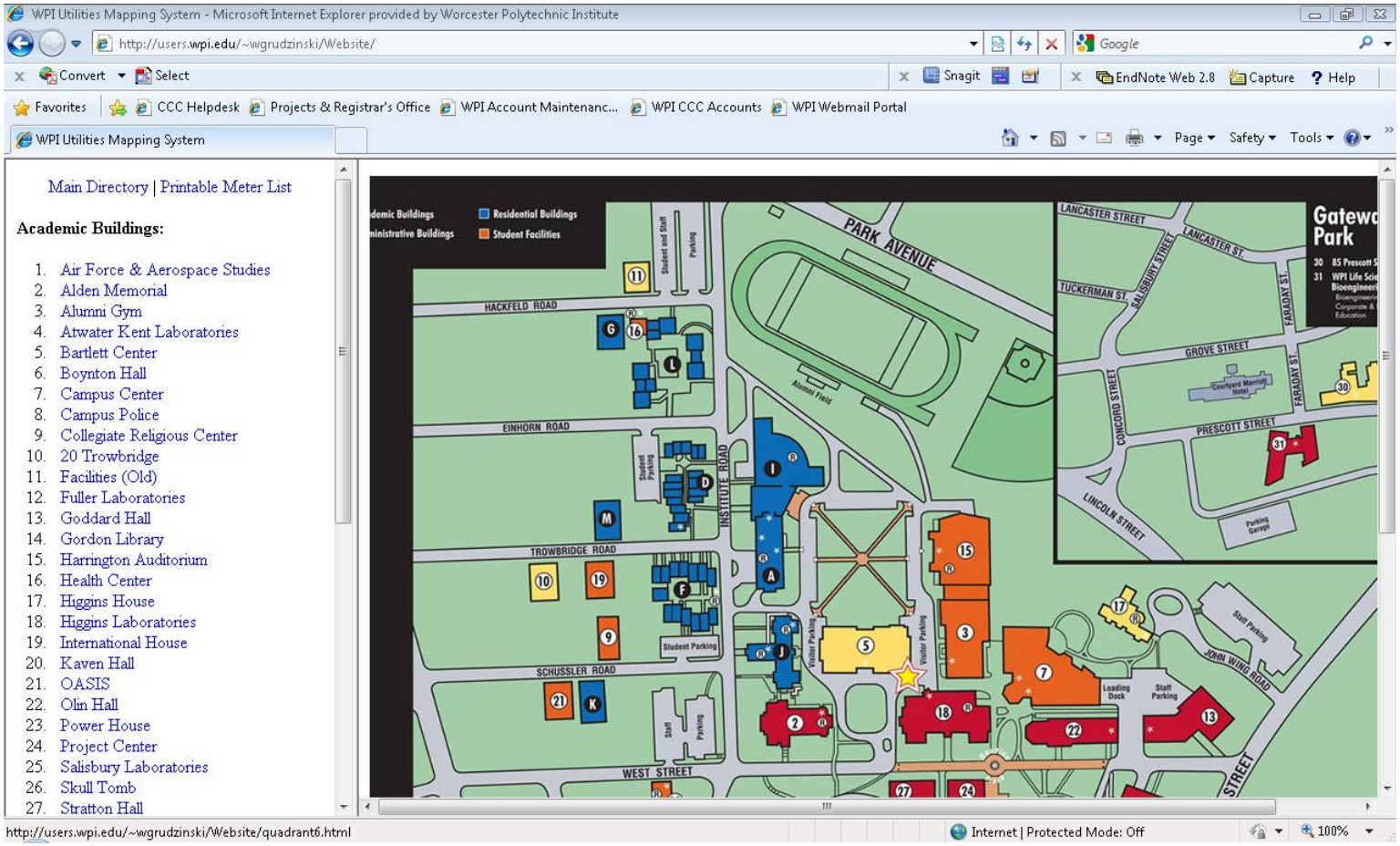


Figure 11. Electricity meter for Stoddard Complex

Campus Map


WPI
HIGHLAND ST. / RTE. 9
ELBRIDGE STREET
INSTITUTE ROAD
WEST STREET
SALISBURY STREET
BOYNTON STREET
DEAN STREET
PARK AVENUE
HACKFELD ROAD
FINDORN ROAD
TROWBRIDGE ROAD
SCHUSSLER ROAD
CONCORD STREET
PRESCOTT STREET
GROVE STREET
FARADAY ST.
LANCASTER STREET
SALISBURY STREET
LINCOLN STREET
JOHN WING ROAD
Gateway Park
Residential Buildings



Proposed Map

WPI Utilities - Power House - Microsoft Internet Explorer provided by Worcester Polytechnic Institute

http://users.wpi.edu/~wgrudzinski/Website/powerhouse.html

Favorites | CCC Helpdesk | Projects & Registrar's Office | WPI Account Maintenanc... | WPI CCC Accounts | WPI Webmail Portal

WPI Utilities - Power House

Power House
187 West Street

National Grid Account Number: 27644-44020
Electric Meter Number: 4848559
Meter Type: G-3
Physical Location: Electric room, Power House Plant

NSTAR Account Number: 28382609999
NSTAR Statement Account Number: 27365800013
Gas Meter Number: X000190
Physical Location: Left side of Stratton Hall

Print this Page | Close this Page

Done | Internet | Protected Mode: Off | 100%

Appendix Q: Relevant Company E-Mails

Mike Thompson, National Grid Representative, Meter/Bill Questions
Received 12/7/2009

1. The meters are read in three ways. The large service for the main campus is read remotely via a phone line. The medium-sized accounts are read manually and the smaller accounts are read using a van equipped with automated meter reading technology (AMR) that drive down the street and reads meters. These are the only technologies we currently use and AMR is not available for medium and large accounts.

2. We try to have 100% actual reads but there are times when the meter readers do not locate the meter or when the AMR device does not pick up the signal. In those cases, the bills are estimated so we can get something out to WPI rather than wait for the next month and bill for two months.

3. The main campus power is fed from our Faraday Street substation. Most of the rest of the campus is fed from this substation as well, but from various feeders, so it is possible for one area to be without power while the rest of the campus has power.

Thank you,

Mike Thompson

Mike Thompson, C.E.M.

Account Executive

National Grid

939 Southbridge Street

Worcester, MA 01610

Phone: (508) 860-6518

Fax: (315) 460-8445

From: Grudzinski, William G [mailto:wgrudzinski@WPI.EDU]
Sent: Friday, November 13, 2009 8:07 PM
To: Thompson, Michael A.
Cc: 'utiliqp@wpi.edu'; Grudzinski, William G
Subject: WPI Project Group - Meter Questions

Hello Mike,

We have made some progress with our project, but have developed a few questions we would like to ask you:

1. How are the electric meters on WPI-owned properties (both on- and off-campus) read? We were wondering whether these were read over the internet/phone lines or if someone physically comes around to check them.
    a. If read electronically, how does that system work? Is it IP technology on internet lines or is it using phone lines?
    b. If read in person, why haven't they looked into going to an electronic reading system? Perhaps there are benefits to having actual people coming around to read them?
2. We noticed that some bills state they were estimated, while others say actual. Is there any reason that some would be estimated and some would be actually read?
3. During our analysis, we began wondering where the electricity that feeds WPI comes from. Is there a substation or a particular plant WPI is fed from? This question arose when we noticed a blackout along Park Avenue a few weeks ago, but WPI was unaffected.

Thank you very much for your continued support of our project, and thanks for taking the time to read these questions. We look forward to hearing from you again soon!

William Grudzinski, Jr.

Mark Hawthorne

Stephen Tetreault

utiliqp@wpi.edu

James Cleary, National Grid Lead Senior Engineer, Co-Generation
Received 11/19/2009

Bill, Mark, Steve,

I'd am buried at work (with DG studies!) but I am very interested in WPI doing the right thing. and would spend some times with you guys if needed.

I would enjoy working with you guys a bit on advise ..whatever.

In fact after that robotic conference I emailed John Orr and a few others complimenting him on that program. I took my son and daughter and enjoyed it. He had emailed me back about NGrid work with Smart Grid in Worcester and I sent him some answers (I was somewhat involved in that). I was going to bring up to him - how I hope WPI seriously considers co-gen or small co-gen for the new building on campus when I learned it was going forward. I think its a perfect building for it with pool (pool heating) and lots of domestic hot water (showers) and thermal demand even in summer ..somewhat.

Large facilities (like UMass hospital 12 to 15 MW peak load) use and will use absorption cooling - using waste heat to take advantage of co-gen thermal waste heat in summer. We are seeing more and more of that.

I am a local alum as you know so I have an interest in WPI's development. I often go to IEEE or ASME talks, project presentation day, MQP presentations, WPI guest speakers etc.

I do think the new Rec center may be a great candidate for co-gen. As you know the key thing is to have some thermal load (mostly year round is possible) to take advantage of co-gen full benefits...and create electricity and allow excess to fed back into the campus to reduce purchases from us.

It may be only that one 75 kW co-gen unit or two of them is all that is needed. I deal with them quite often actually. I do DG interconnections studies at National Grid.

He is a sample of a recent small co-gen job in Worcester (see attached email and screening memo we do to check things). treat it confidentially...should not be a problem but just use it for your own and WPI's use.

Common things (distributed generation) I see being put in by private developers and investors:

co-gen systems 75 kW is common - Worcester housing authority is in the process of putting in 3 system in Worcester. We just got those application and we do a Screening analysis to make sure there are no complex problems associated with the electrical interconnect.

The 75 kV co-gen units can give off about

I see wind turbines: I did the impact study for Holy Name, (600 kW) en electrically heated high school, Jiminy Peak in Hancock, MA (ski area - high electrical demand in winter), Richey Woodworking in Newburyport just put in a 600 kW in January.

Solar farms- I have about 50 MW of proposed solar projects in Central Ma that I am studying.

UMass hospital, Smith college both I was recently involved with from the electric utility perspective on Co-gen installations or upgrades. UMass has 10 MW of generators and Smith did a 3.5 MW co-gen unit

Jim Cleary WPI '86 EE

MBA 1991

James Cleary, P.E.
Lead Senior Engineer
Network Asset Planning
Electricity Distribution Operations
National Grid USA
(508) 860-6369

Appendix R: Clark University Pamphlet

Provided by Roy Cordy, chief engineer at Clark University

Nov-09

Power Plant Report

actual

ELECTRICAL USAGE :		TOTAL		**986,970**	KWH
HEAT USAGE		TOTAL		~~7,832~~ 7,557	MBTU'S
COGENERATION :					
MODE OF OPERATION:	(6) Campus Load all week				
Energy inputs to generate			**kw**	**970,050**	
Hours	720				
HP Gas	100,647	Therms @	0.945	$	95,111
Diesel Fuel	4260	Gals @	1.8	$	7,668
Lube oil	390	Gals @	9.45		3,686
Chemicals	718	Hrs @	0.5		359
Total Cost Inputs				**$**	**106,824**
COGEN SALES:					
On Peak	KWH @	0.0291834			0
Off Peak	KWH @	0.0212895			0
Dispatch	0 KWH @	0.055			0
Total	0 KHW	Net sales		**$**	-
HEAT CREDITS:					
	2994 MBTU'S @	$ 12.33		**$**	**36,916**
COST ANALYSIS:					
Total Energy Inputs				$	106,824
Labor and Maintenance Inputs				$	8,838
		Total Cogeneration cost		**$**	**115,662**
Gross Cost KWH				**$**	**0.1171**
Net cost KWH				**$**	**0.1100**
Campus Net Cost KWH of Production (less Fixed Cost)				**$**	**0.0720**

Page 1

PURCHASED POWER COST INCLUDING KVA / KW DEMAND

Demand :			1787 KW
Total On Peak & Off Peak Purchased Electricity:			16,920 KWH
Total Purchased Electricity Cost:		$	**2,223.29**
Average electricity cost :		$	**0.131**

BOILER ROOM ENERGY INPUT:

Cooling Deg. Days:	0				
Heating Deg Days:	613				
# 6 Oil		GALS @		$	-
Interruptible Gas	65,376	THERMS @	0.8885	$	58,087
Total Boiler Fuel Cost:				$	58,087
Cost of One MBTU of Thermal Energy @ 72% Boiler Efficiency:				$	12.33
TOTAL ENERGY EXPENDITURES FOR THE MONTH				**$**	**175,972**

NO COGENERATION COST ANALYSIS:

Current Demand:	2400 KW				
Electricity savings	41.375 KW				
Credit for electricity savings (1278 kw-hr/day summer, 993 kw-hr/day winter)					($2,635.00)
Credit for maint.& labor					($8,838)
Cost of generating	7557	MBTU'S:	12.33	$	93,178
Cost of purchasing	986,970	KWH @	0.131	$	150,204
Total :				**$**	**231,909**
SAVING WITH COGEN				**$**	**55,937**

POWER PLANT REPORT

Formula's 198

Actual

Electrical usage: KWH

Heat usage: MBTU's

Cogeneration:

Mode of operation:

Energy inputs to generate KWH C

Hours			
H P Gas	CCF x		$
Diesel:	gals. x		
Lube Oil:	gals. x		
Chem.	hrs. x		
		Total Cost Inputs	$ A

Cogen Sales:

On Peak	x		$
Off Peak	x ____ K KWH	Net Sales	$ S

Heat Credits:

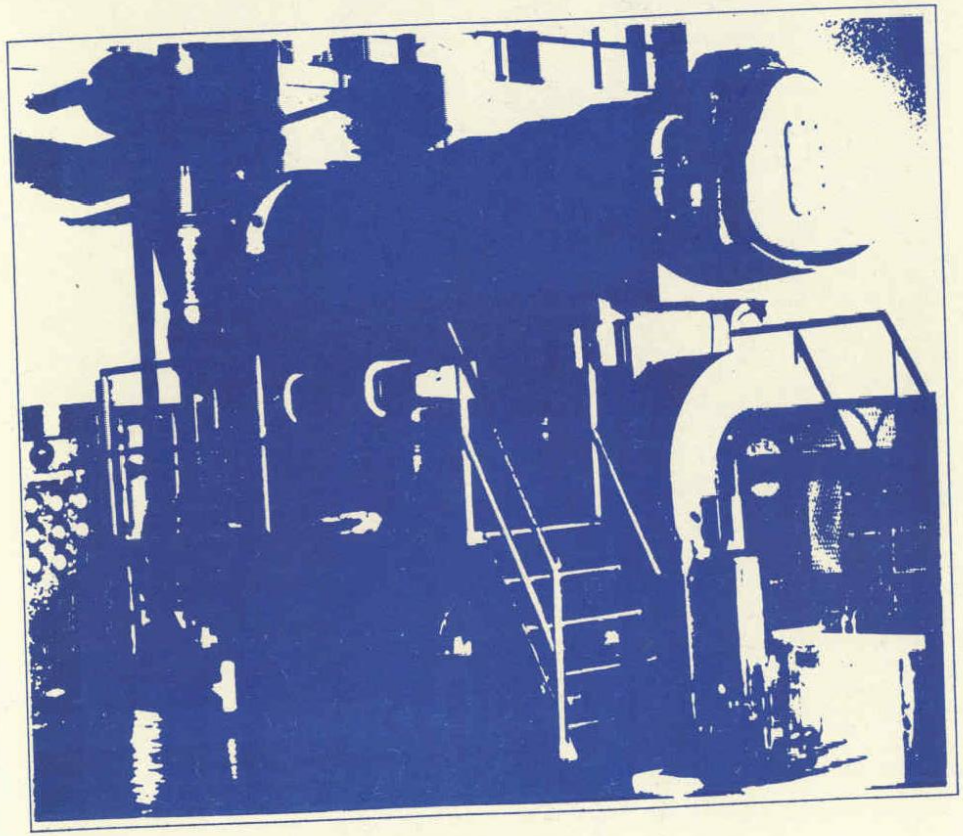
MBTU's Used on Campus x $ H

Cost Analysis:

Total energy inputs		$ A
Labor and maintenance inputs		B
	Total Cogeneration Cost	$
Gross Cost KWH		$A + B ÷ C
Net Cost KWH		A + B − H ÷ C
Campus Net Cost KHW of Production (Less Fixed Costs)		A − H − S ÷ (C − K)

Purchased Power Cost using	KVA demand and	KWH usage	$ P
		Average Cost KWH	
Boiler Room: Number of degree days			
Energy inputs:			
#6 Oil:	gals. x		
Interruptable Gas:	CCF x		$
		Total Boiler Cost	$ Z
Analysis:			
Total Measured MBTU's	cost per MBTU		$
Total Energy Expenditure for month			$ A + P + Z
No Cogeneration costs:			
MBTU's Cost Z + H			$
#6 Oil	gals. x		
Purchase	KWH x		
Demand	KVA		$
		Savings with Cogeneration	$

COGENERATION
AT • CLARK • UNIVERSITY •

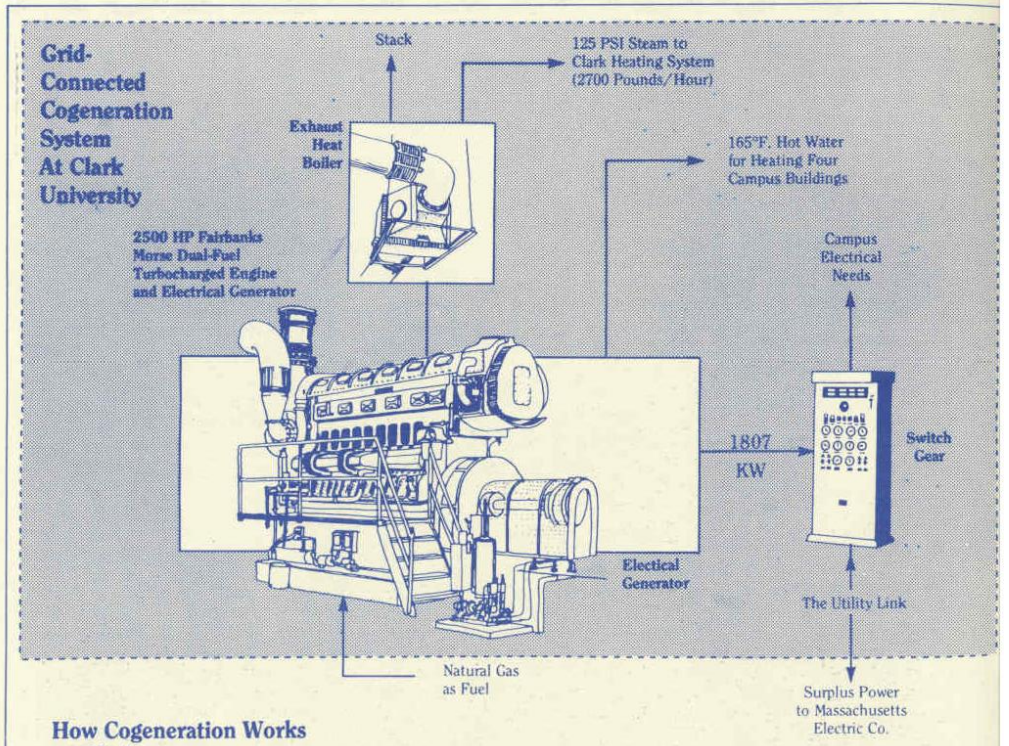


Dedicated on May 22, 1982, the Integrated Community Energy System at Clark serves as an example of the kind of research undertaken by the University throughout its history. As a small, research University with a tradition of social responsibility, and with frequent collaboration among natural and social scientists who are able to work across disciplinary boundaries, Clark offers students and faculty an environment in which they translate academic research into practical solutions to current problems.

And in the case of the cogeneration facility, these practical applications provide immediate benefits — substantial annual savings of both dollars and fuel.

But the cogeneration process as demonstrated at Clark also will have a much broader and long-range impact. As a country that has underutilized the cogeneration process, the United States might benefit dramatically from encouraging emulation of the Clark model. For every 45 minutes that the Clark cogeneration system is operating, it saves the equivalent of one barrel of oil. If similar cogeneration processes could be used to produce one half the electricity currently generated in the United States by oil and gas, the savings nationally would amount to more than 1.5 million barrels of oil in a single day, or roughly 25 percent of the country's current oil import level.

Beyond providing a practical model of the cogeneration process itself, the Clark project has provided an unusual, if not unprecedented, model of public-private cooperation. The experience gained in forging a partnership between public utility and private generator should have even more far-reaching effects within the next two decades. As the United States works to free itself from dependence on foreign oil sources and to emphasize energy conservation, it will turn more and more to emerging technologies: Renewable energy sources such as solar, wind, trashburning, and biomass—all will function as small decentralized systems, and, like Clark's cogeneration plant, these systems will function far more efficiently when linked to an electric utility. The "socio-technology" that has enabled a private university to negotiate a working agreement with a public utility will be needed to help solve the political and institutional problems that, to date, have prevented this country from maximizing its cogeneration potential.



How Cogeneration Works at Clark

The Clark Integrated Community Energy System (ICES) serves as a demonstration model for potential cogenerators—and for energy policy makers—of the benefits to be gained from such plants. At Clark, those benefits include fuel savings equivalent to 8500 barrels of oil a year and cost savings projected at about $250,000 for the first year alone—which will increase as the price of fuel rises.

Such dramatic savings are made possible by a process that uses fuel—in this case natural gas—more efficiently than it is used in the production of electricity at a utility plant.

In a typical central station utility plant, 35 percent of the energy produced by burning fuel becomes electric power, but 40 to 45 percent is rejected as "waste" or byproduct heat. Utility plants normally dispose of this

waste best by "dumping" it into a nearby body of water. Another 20 percent is lost up the smokestack of the boiler (or, in the case of nuclear processors, through the condenser).

In the cogeneration process, on the other hand, most of the thermal energy normally rejected as waste in central utility plants is recaptured and used for space heating (or air conditioning) after it has been used for electrical generation. In the Clark system about 35 percent of the energy from the system's fuel is converted directly into electricity and an additional 34 percent is recaptured from the engine's exhaust and cooling jacket to be used for heating, air conditioning, and hot water. Thus, the cogeneration system uses the original fuel nearly twice as efficiently as it would be used elsewhere in the utility system.

The Clark system is unusual in its use of an internal combustion engine as the power source instead of a conventional, less-efficient steam system. The heart of the Clark installation is an 1807 KW electric generator, driven by a 2500 HP natural gas-fired diesel engine, built by Fairbanks Morse. The engine and generator operate almost continuously at full load, except during regularly scheduled down time for maintenance and a few periods of low thermal demand.

From May to September, the heat recovered from engine exhaust, along with the use of some new "satellite" domestic hot water equipment, allows Clark to shut down its existing boiler plant. During this period, some of the recovered heat is dissipated in a cooling tower on the roof of the library, while additional recovered heat supplies steam to the University's air conditioning absorption chiller.

During the heating season, exhaust heat is captured in the form of 125 pounds-per-square-inch steam and is supplied to the University steam system. Some of the exhaust is captured in the form of hot water and used to heat several of Clark's buildings, including the Academic Center, the Geography Building, and Goddard Library. On cold days, this heat is supplemented by the boiler plant.

Another unique aspect of the Clark pilot project is the relative volume of electric power generated; although a number of facilities already generate some electricity using cogeneration, they provide a relatively small amount of the total institutional energy usage. By contrast, the Clark plant, when run at full capacity, provides all campus electricity needs as well as continuously feeding surplus electric power to the Massachusetts Electric Company's grid.

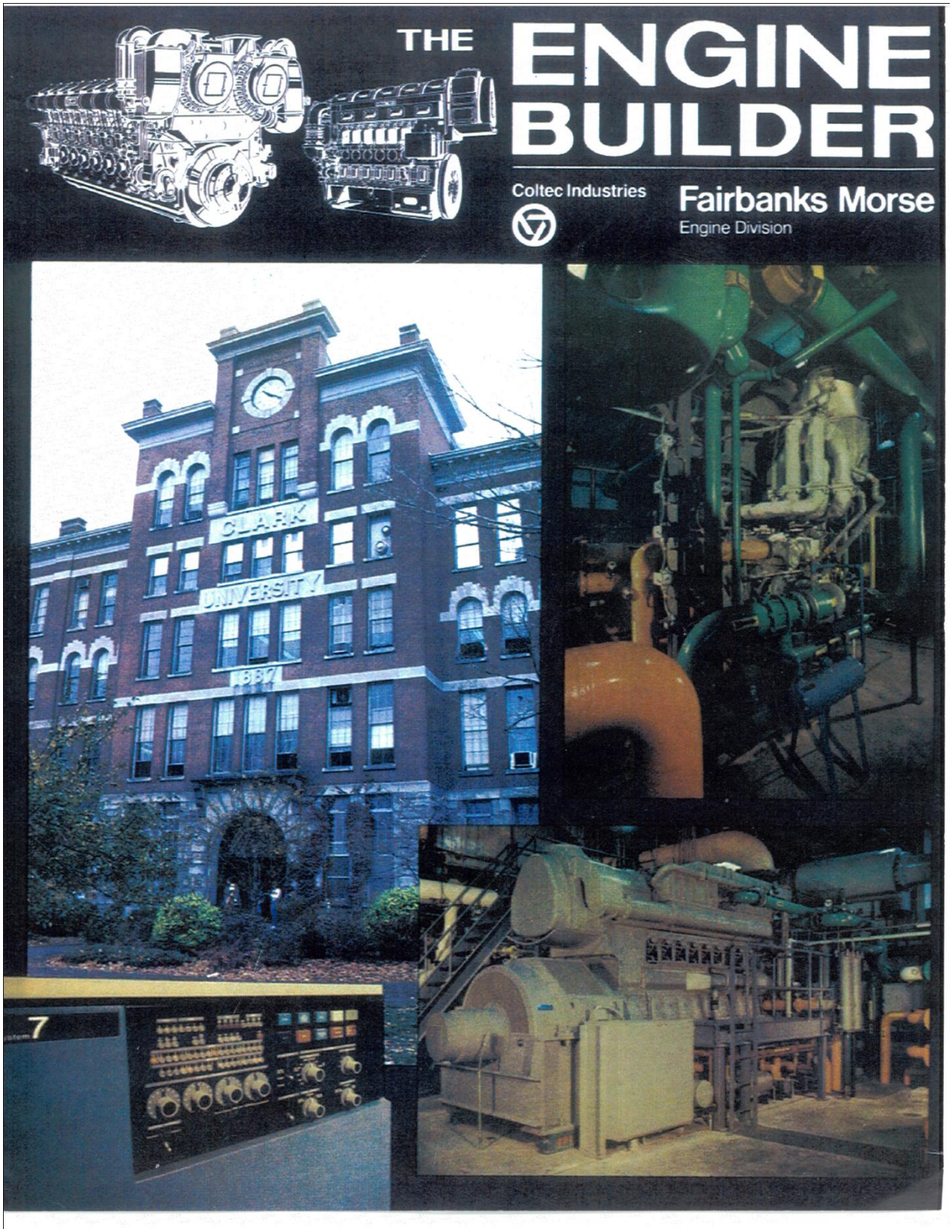
The fuel economy of the Clark installation depends critically on this link to the electric utility. Thermal energy is produced as a "byproduct" in proportion to the amount of electricity generated; with the utility link, Clark's engine can be run to satisfy the University's heating and cooling needs, whether or not the campus requires all the electricity initially generated. Thus, the utility tie maximizes the Clark system's benefits, enabling the University to produce electricity according to its *thermal* requirements rather than having to confine the system's operation to electricity demand alone. The price the utility pays for the surplus Clark feeds into the grid system is based on fuel costs the utility avoids by purchasing the electric power from Clark.

Since the idea for the plant was first introduced in the early seventies—in the term papers of three Clark undergraduate students—the concept has become even more attractive as the dramatic increase in fuel prices and the changing attitude of the utilities toward private independent plants have made cogeneration more financially feasible. The Clark plant serves as a model—not only of more efficient use of natural resources, but of University/utility cooperation that should smooth the way for other institutions, both profit and nonprofit, that may be interested in cogeneration.

Mass. Electric Construction Company of Boston served as the principal contract manager for the project. Energy Services Management Corp. of Boston designed and specified the cogeneration system; and the Aldrich Co., Inc., Cochituate, Massachusetts designed the 1½-story building which houses it. The engine/generator set was built by Fairbanks Morse Engine Division, Colt Industries, Beloit, Wisconsin; and switch gear was designed and built by Russelectric Inc. of Hingham, Massachusetts. Commonwealth Gas Company serves as the system's supplier of natural gas.

From the outset, the project has had financial support from the Department of Energy, and received a $1.2 million loan through the Department of Housing and Urban Development in addition to outright grants from the George F. and Sybil H. Fuller Foundation and the Wyman-Gordon Company, both of Worcester.

CLARK UNIVERSITY
950 Main Street Worcester, MA 01610


THE
ENGINE
BUILDER
Coltec Industries
Fairbanks Morse
Engine Division
CLARK
UNIVERSITY

THE ENGINE BUILDER

Cover Photo

Left Top—The Clark University Building in Worcester, Mass. founded in 1887.
Right Top—A pipe fitter's nightmare. A view of the free end of Clark's F-M O.P.
Left Bottom—Clark University's computerized energy monitoring system.
Right Bottom—This Fairbanks Morse 9 cyl. Turbocharged dual fuel O.P. is the heart of Clark's cogeneration system.

Coltec Industries

Fairbanks Morse
Engine Division

CLARK UNIVERSITY'S COGENERATION PLANT BEGINS OPERATION

The nation's first power-grid-connected cogeneration demonstration power plant recently began operation at Clark University in Worcester, Massachusetts. The new plant's interconnection with the electric power grid of the Massachusetts Electric Company sets it apart from other currently operating cogeneration systems.

Cogeneration means the simultaneous production of energy in two forms. At Clark University, both heat and electricity are being produced.

The key element in Clark's cogeneration system is a Fairbanks Morse 9-cylinder turbocharged dual fuel opposed piston engine. Developing 2500 horsepower, it drives a generator rated at 1807 kw.

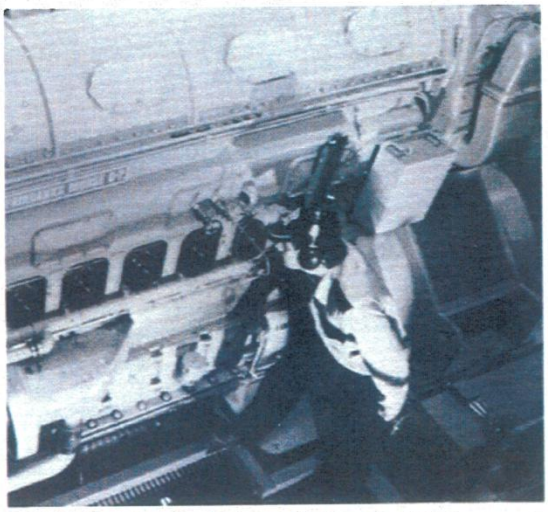
The engine is located next to an existing steam plant which is used for campus heating and hot water. Engine exhaust gases are piped into a Riley Beaird exhaust boiler producing steam at 125 lbs. pressure, the same pressure produced by the existing steam plant. The steam is used for building heating and domestic hot water. The jacket water and lube oil coolers provide additional heat in the form of hot water which is used to heat four buildings adjacent to the power plant.

Interconnection with the electric grid of the Massachusetts Electric Company enables the University to sell approximately 40% of the engine generated power to the utility. The Clark cogeneration system will achieve an efficiency of about 70% while producing both heat and electricity, compared with a 35% efficiency rating for electricity generated in a conventional central power station. Heat recovered from the engine will allow Clark to shut down its existing boiler plant from May through September. According to Cogeneration Manager, Don Stockwell, this will result in a net savings for Clark University and the U.S.A. of approximately 357,000 gallons of oil per year.

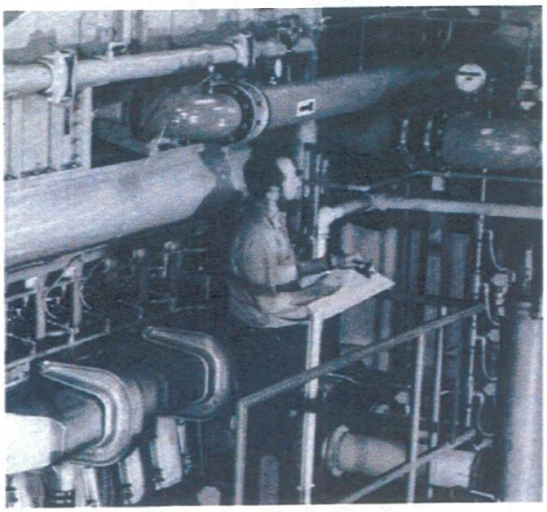
Clark University's power plant is the first of five model cogeneration plants to begin operating under the Community Energy Systems Program of the Department of Energy.

Under the program, Clark, using a computerized data collection system, will periodically report plant performance to the D.O.E.

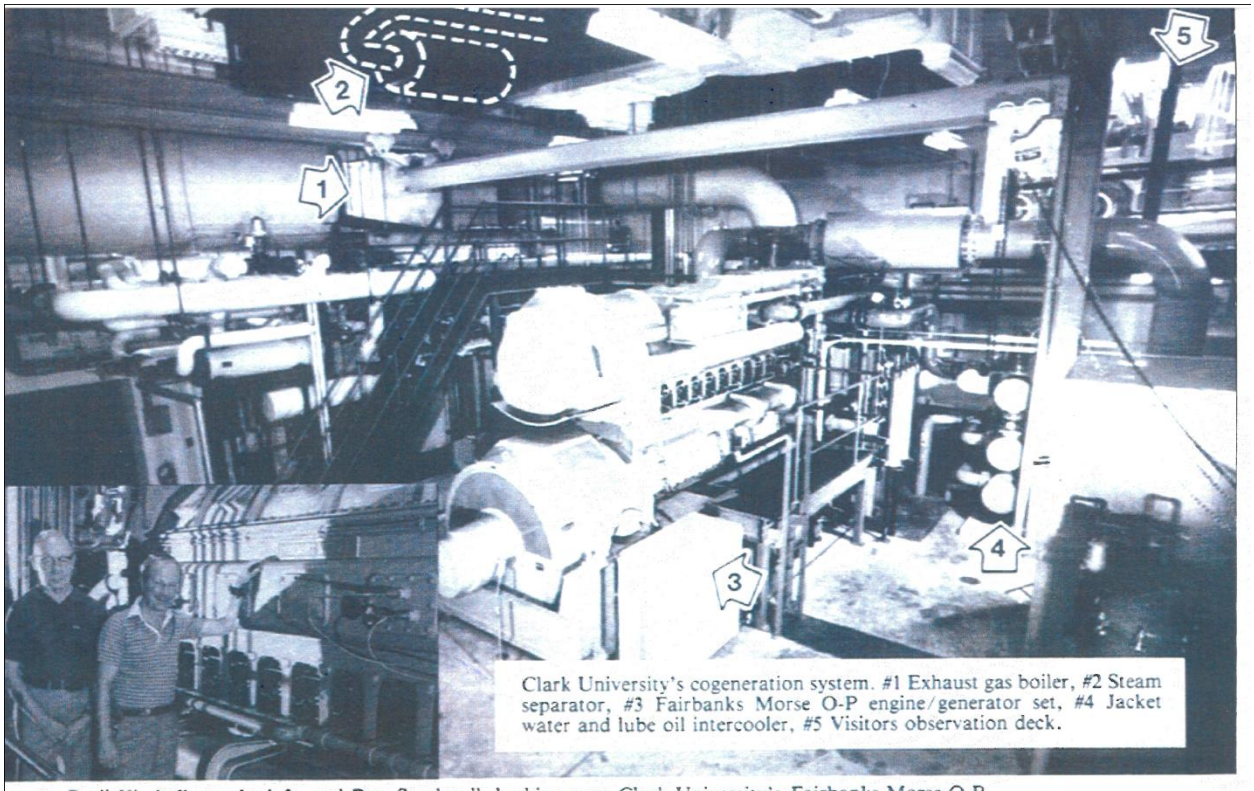
Fairbanks Morse is proud to be a part of this program at Clark and our assistance was appreciated. "We were fortunate that much of the design of the plant was done by Fairbanks Morse," says Basil Kimball, Clark's plant engineer. "They did an excellent job in design and worked closely with us all along, advising us not only on their equipment, but on related equipment as well."



W. Oren Locke checks and logs engine temps.

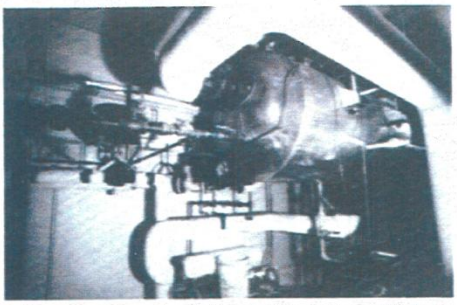


John LaPointe, plant operator, monitors engine performance.

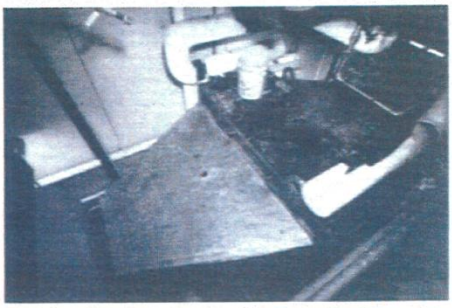


Clark University's cogeneration system. #1 Exhaust gas boiler, #2 Steam separator, #3 Fairbanks Morse O-P engine/generator set, #4 Jacket water and lube oil intercooler, #5 Visitors observation deck.

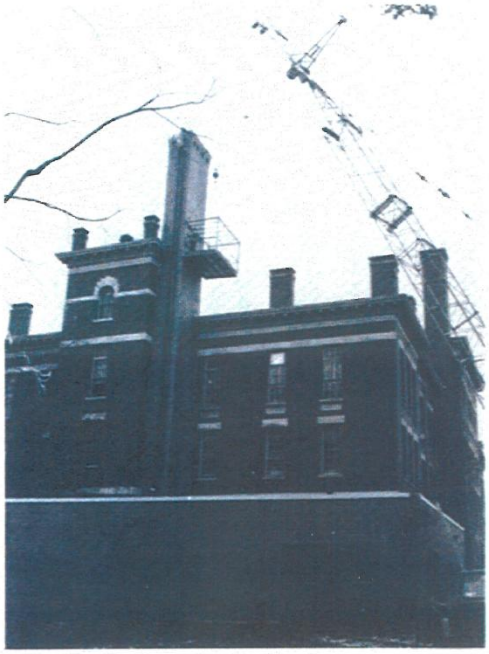
Basil Kimball, on the left, and Don Stockwell, looking over Clark University's Fairbanks Morse O-P.



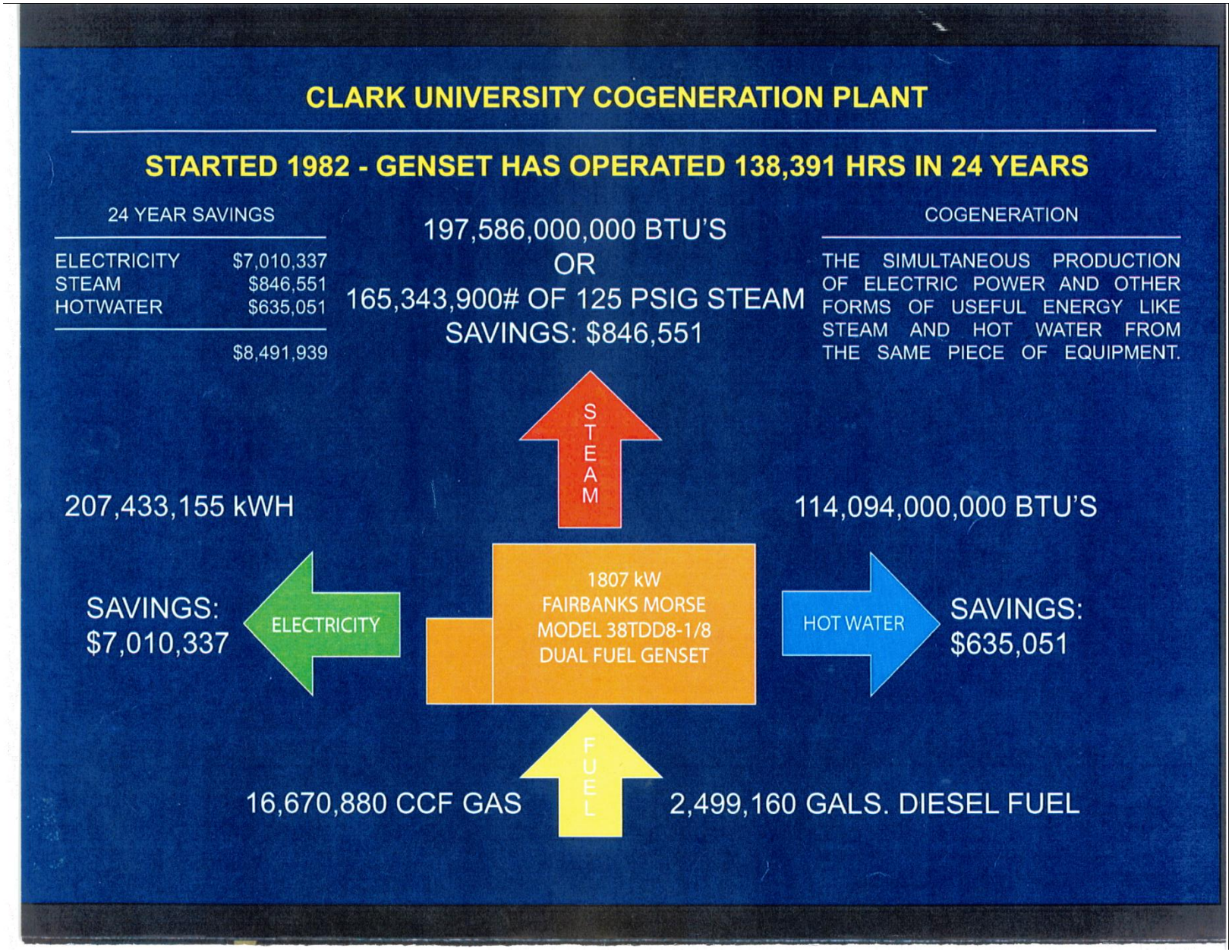
The steam separator is located just above the heat recovery boiler.



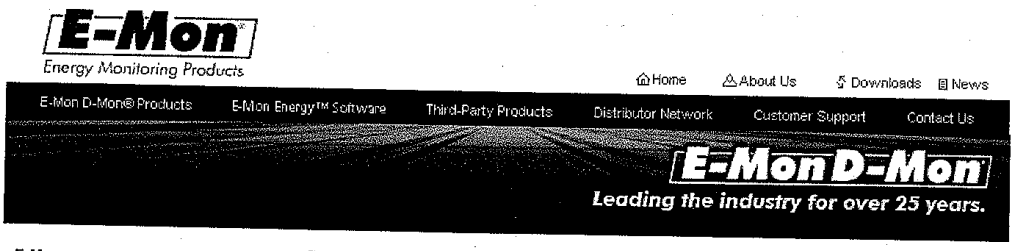
A Maxim GTW50-P4D heat recovery boiler with an internal gas divert valve recovers waste heat from the engine exhaust gas.



Clark's cogeneration system is housed in the modern 1-story building in the foreground. The engine exhaust gases are piped out of the 95 ft. chimney.


CLARK UNIVERSITY COGENERATION PLANT
STARTED 1982 - GENSET HAS OPERATED 138,391 HRS IN 24 YEARS
24 YEAR SAVINGS
ELECTRICITY $7,010,337
STEAM $846,551
HOTWATER $635,051
$8,491,939
197,586,000,000 BTU'S
OR
165,343,900# OF 125 PSIG STEAM
SAVINGS: $846,551
COGENERATION
THE SIMULTANEOUS PRODUCTION OF ELECTRIC POWER AND OTHER FORMS OF USEFUL ENERGY LIKE STEAM AND HOT WATER FROM THE SAME PIECE OF EQUIPMENT.
STEAM
207,433,155 kWH
114,094,000,000 BTU'S
SAVINGS: $7,010,337
ELECTRICITY
1807 kW
FAIRBANKS MORSE
MODEL 38TDD8-1/8
DUAL FUEL GENSET
HOT WATER
SAVINGS: $635,051
FUEL
16,670,880 CCF GAS
2,499,160 GALS. DIESEL FUEL

Appendix S: E-Mon D-Mon Data Sheet



E-Mon
850 Town Center Drive
Langhorne, PA 19047
(800) 334-3666 toll-free
(215) 752-0601 main
(215) 752-3094 fax
info@emon.com e-mail

E-Mon, established in 1981, is the industry leader in the manufacture of solid-state electronic kilowatt-hour submeters, automatic meter reading software and other energy management products and services. E-Mon's products are installed worldwide for tenant billing, cost allocation, demand side management, energy conservation and load profiling in skyscrapers, shopping centers, airports, factories, office buildings, apartment buildings, college campuses and government facilities.

After several years of research and development, E-Mon brought the first fully electronic kilowatt hour submeter to market. This product, the E-Mon D-Mon, quickly became the industry standard, making E-Mon the leader in the submetering market. Since that time, E-Mon has continued to expand its product line with state-of-the-art technology in demand profile analysis and energy consumption aggregation.

To position itself for international growth, E-Mon has established a network of over 4,000 distributors supported by independent sales representative agencies throughout the world. E-Mon maintains in-house engineering staff for hardware/software development and sales and technical support staff for pre- and post-sale assistance. The company's customer base ranges from small retail stores to Fortune 500 corporations.

Fuller
Riley
Morgan/Daniels → same

Chris Salter
Projects Manager

Pulse meters

No real info/data yet

http://www.emon.com/about.htm

1/21/2010

IDR (Interval Data Recorder)

E-Mon D-Mon
Energy Monitoring Products & Systems

Features

- Reads & records up to 8 or 16 E-Mon D-Mon Electric meters.
- IDR-ST model can accept contact closure type pulse inputs from other types of meters (water, gas, BTU, steam, etc.)
- RS-485 communications capability supports the following connection configurations (or combinations not to exceed 52 devices per channel):
  - Up to 52 IDR-8 interval data recorders
  - Up to 26 IDR-16 interval data recorders (IDR-16 counts as two devices)

  Cabling can be either daisy-chain or star configuration, 4-conductor, 24-26 AWG, up to 4,000 cable feet total per channel.
- Communication Options
  - RS-232/RS-485 (Standard)
  - Telephone Modem
  - Ethernet
  - Modbus RTU or Modbus TCP/IP
  - BACnet IP or BACnet MS/TP
  - LONworks TP (Twisted Pair)
- Internal data storage-36 days of 15-minute intervals. Maintains last 36 days of data.
- Reads kWh (kilowatt-hours) and reads kW (Demand) in 15, 30 or 60-minute kW periods.
- Standard IDRs do not require a separate power source (power supplied by E-Mon D-Mon electric meters.) IDR-ST models require a separate 120V power source (included with IDR-ST models.)
- Maintains data in case of power outage.
- Industrial-grade JIC steel enclosure with padlocking hasp and mounting flanges. (For indoor use only.)
- Three 1 1/16" knockouts (3/4" conduit) on bottom of enclosure.
- IDR data accumulators can be mounted on the inside back wall of the MMU cabinet and shipped from the factory in one complete package.
- MV-90 compatible.

Dim: 9 1/2" H x 6 3/4" W x 3 3/4" D

Model Numbers

IDR-8 (Up to 8 meters)
IDR-16 (Up to 16 meters)

*For optional screw terminals in place of all RJ jacks add suffix ST to the model number.
Example: IDR-8-ST

* For IDR-16 with 8 RJ jacks and 8 screw terminals add suffix RJST to the end of the model number. Example: IDR-16-RJST

Built-In Communication Options

Telephone Modem (Suffix M)
Ethernet Communication (Suffix E)
Modbus RTU Communication (Suffix RTU)
*Modbus TCP/IP Communication (Suffix ERTU)
*BACnet IP Communication (Suffix EB)
BACnet MS/TP Communication (Suffix B)
LONworks TP Communication (Suffix LTP)

* Modbus TCP/IP and BACnet IP communicate over Ethernet. No RS-485 daisy-chain capabilities with Modbus TCP/IP & BACnet IP. Each IDR must connect directly to the BACnet/Modbus backbone and have a unique IP address.

E-Mon
Energy Monitoring Products

(800) 334-3666 - www.emon.com

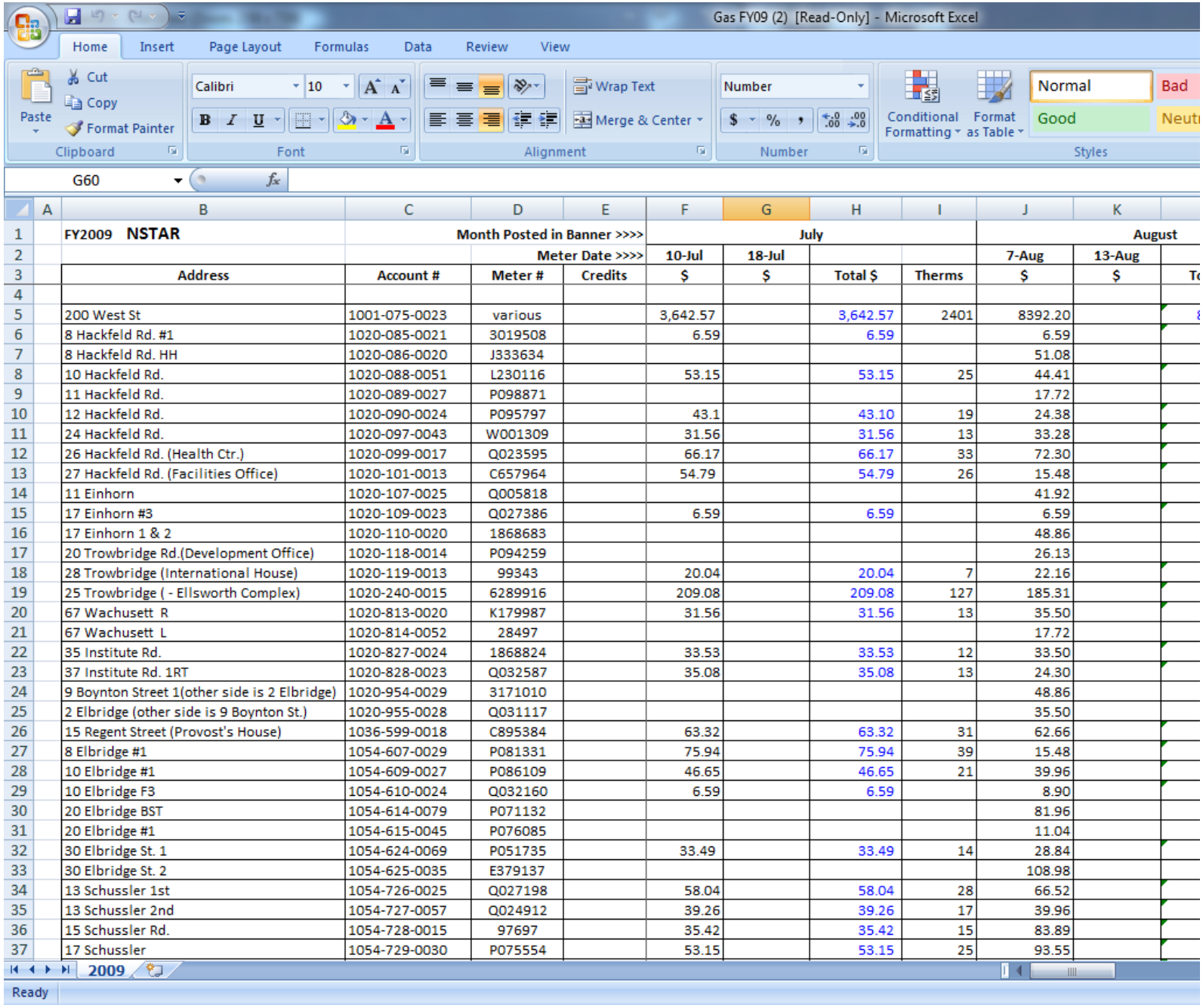
Effective Date: 10/8/2009

Appendix T: Marylou's Billing Spreadsheet

Example of Electric, Financial Year 2009

Electric FY09 (2) [Read-Only] - Microsoft Excel

Address	NGRID Account #	Meter #	Rate Class	26-Jun $	16-Jul $	July Total $	KWH	18-Aug $	18-Aug $	18-A
09		Month Posted in Banner (see NOTE below) >>>>								
		Meter Date >>>>								
47 Institute, apt. 2	40089-82003	56960077	R1		42.58	42.58	227	54.59		
9 Institute HSMTR pole 3	65016-44002	98714235	G1		32.77	32.77	139	36.96		
49 Institute, apt. 1	52550-61007	60064136	R1		69.22	69.22	430	75.14		
9 Institute, apt. 2 pole 3	89946-44001	82241928	R1		114.39	114.39	712	105.27		
9 Institute, apt. 3 pole 3	77476-60007	60114073	R1		68.08	68.08	423	76.93		
79 Institute HSMTR	89946-53000	82764296	G1						1,676.59	
79 Institute apt. 1	15193-57004	64289578	R1	2.55		2.55				
79 Institute apt. 2	65016-54008	73010900	R1	24.97		24.97				
79 Institute apt. 3	40089-93006	58384464	R1	19.06		19.06				
79 Institute apt. 4	40089-92009	11186422	R1	6.54		6.54				
79 Institute apt. 5	52552-65005	72848519	R1	14.89		14.89				
79 Institute apt. 6	52552-64008	73010904	R1	12.96		12.96				
79 Institute apt. 7	27629-22003	10131549	R1	4.96		4.96				
79 Institute apt. 8	02841-79004	62295761	R1	5.90		5.90				
79 Institute apt. 9	77476-70003	07752754	R1	20.79		20.79				
79 Institute apt. 11	89946-54007	72905649	R1	30.11		30.11				
79 Institute apt. 12	15193-56007	73010906	R1	8.47		8.47				
79 Institute apt. 13	02841-80007	07752824	R1	18.25		18.25				
79 Institute apt. 14	27629-21006	73010903	R1	11.83		11.83				
79 Institute apt. 15	27629-20009	87029745	R1	3.99		3.99				
79 Institute apt. 16	40089-91002	34681754	R1	9.61		9.61				
79 Institute apt. 17	15193-55000	40246466	R1	7.03		7.03				
79 Institute apt. 18	52552-63001	22063119	R1	6.06		6.06				
79 Institute apt. 19	02841-78007	35587027	R1	4.96		4.96				
79 Institute apt. 21	52552-62013	73010923	R1	22.90		22.90				
79 Institute apt. 22	89946-52003	22064134	R1	3.99		3.99				



	A	B	C	D	E	F	G	H	I	J	K
1		FY2009 NSTAR		Month Posted in Banner >>>>		July				August	
2				Meter Date >>>>		10-Jul	18-Jul			7-Aug	13-Aug
3		Address	Account #	Meter #	Credits	$	$	Total $	Therms	$	$
4											
5		200 West St	1001-075-0023	various		3,642.57		3,642.57	2401	8392.20	
6		8 Hackfeld Rd. #1	1020-085-0021	3019508		6.59		6.59		6.59	
7		8 Hackfeld Rd. HH	1020-086-0020	J333634						51.08	
8		10 Hackfeld Rd.	1020-088-0051	L230116		53.15		53.15	25	44.41	
9		11 Hackfeld Rd.	1020-089-0027	P098871						17.72	
10		12 Hackfeld Rd.	1020-090-0024	P095797		43.1		43.10	19	24.38	
11		24 Hackfeld Rd.	1020-097-0043	W001309		31.56		31.56	13	33.28	
12		26 Hackfeld Rd. (Health Ctr.)	1020-099-0017	Q023595		66.17		66.17	33	72.30	
13		27 Hackfeld Rd. (Facilities Office)	1020-101-0013	C657964		54.79		54.79	26	15.48	
14		11 Einhorn	1020-107-0025	Q005818						41.92	
15		17 Einhorn #3	1020-109-0023	Q027386		6.59		6.59		6.59	
16		17 Einhorn 1 & 2	1020-110-0020	1868683						48.86	
17		20 Trowbridge Rd.(Development Office)	1020-118-0014	P094259						26.13	
18		28 Trowbridge (International House)	1020-119-0013	99343		20.04		20.04	7	22.16	
19		25 Trowbridge (- Ellsworth Complex)	1020-240-0015	6289916		209.08		209.08	127	185.31	
20		67 Wachusett R	1020-813-0020	K179987		31.56		31.56	13	35.50	
21		67 Wachusett L	1020-814-0052	28497						17.72	
22		35 Institute Rd.	1020-827-0024	1868824		33.53		33.53	12	33.50	
23		37 Institute Rd. 1RT	1020-828-0023	Q032587		35.08		35.08	13	24.30	
24		9 Boynton Street 1(other side is 2 Elbridge)	1020-954-0029	3171010						48.86	
25		2 Elbridge (other side is 9 Boynton St.)	1020-955-0028	Q031117						35.50	
26		15 Regent Street (Provost's House)	1036-599-0018	C895384		63.32		63.32	31	62.66	
27		8 Elbridge #1	1054-607-0029	P081331		75.94		75.94	39	15.48	
28		10 Elbridge #1	1054-609-0027	P086109		46.65		46.65	21	39.96	
29		10 Elbridge F3	1054-610-0024	Q032160		6.59		6.59		8.90	
30		20 Elbridge BST	1054-614-0079	P071132						81.96	
31		20 Elbridge #1	1054-615-0045	P076085						11.04	
32		30 Elbridge St. 1	1054-624-0069	P051735		33.49		33.49	14	28.84	
33		30 Elbridge St. 2	1054-625-0035	E379137						108.98	
34		13 Schussler 1st	1054-726-0025	Q027198		58.04		58.04	28	66.52	
35		13 Schussler 2nd	1054-727-0057	Q024912		39.26		39.26	17	39.96	
36		15 Schussler Rd.	1054-728-0015	97697		35.42		35.42	15	83.89	
37		17 Schussler	1054-729-0030	P075554		53.15		53.15	25	93.55	

Example of Gas, Financial Year 2009

Appendix U: Project Team Data Entry

Electric accounts, August 2009 – September 2009

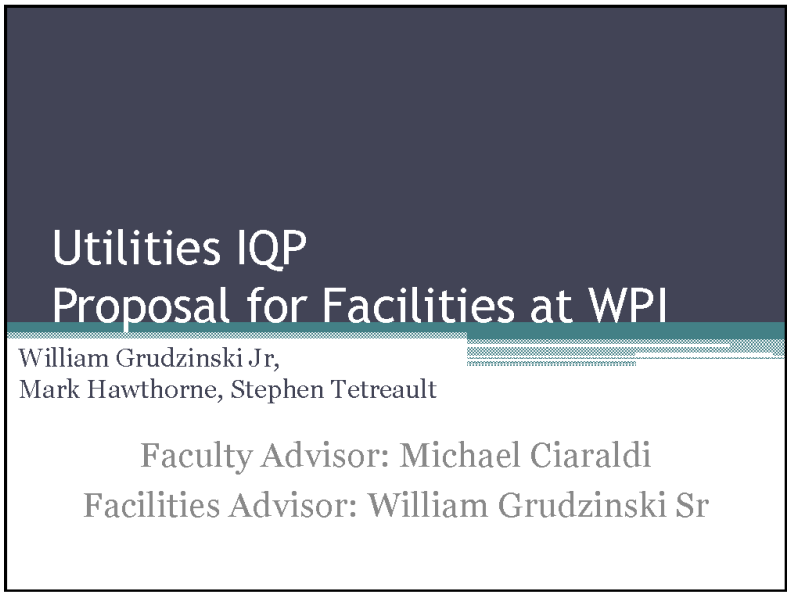
August-Sept Bills (Electric) - Microsoft Excel

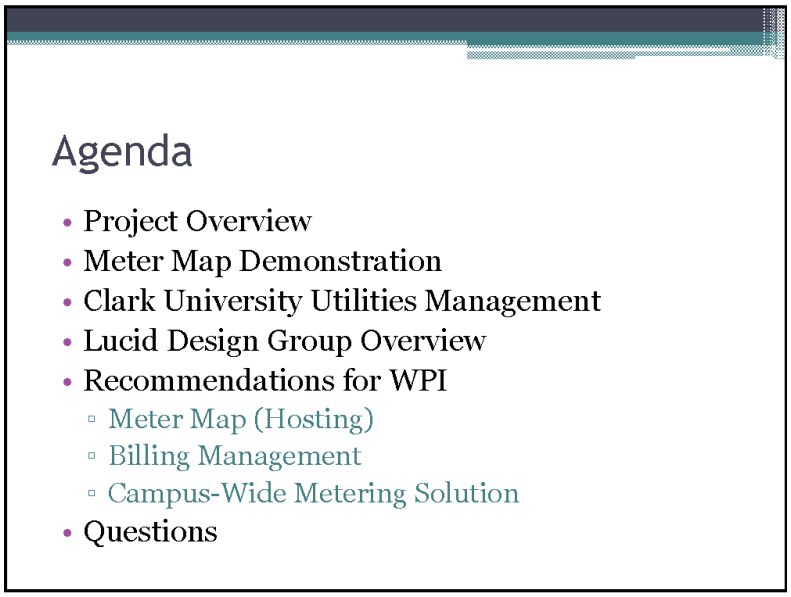
Company Name	Utility	Service For	Start/End	Amount Due	Due Date	Account #	Total Usage
National Grid	Electricity	9 Boynton St Apt 1	8/18/09 - 9/17/09	58.33	10/14/2009	89946-43004	365 kWh
National Grid	Electricity	12 Boynton St	8/17/09 - 9/18/09	1107.21	10/14/2009	65016-38004	9840 kWh
National Grid	Electricity	26 Boynton St Pole MH338	8/17/09 - 9/18/09	9114.31	10/14/2009	27628-90015	87520 kWh
National Grid	Electricity	30 Boynton St	8/17/09 - 9/18/09	3755.77	10/14/2009	91577-49006	123000 kWh
Direct Energy	Electricity	30 Boynton St					
National Grid	Electricity	1 Drury Ln	8/18/09 - 9/17/09	454.15	10/14/2009	52559-67004	3136 kWh
National Grid	Electricity	11 Einhorn Rd	8/18/09 - 9/17/09	232.5	10/14/2009	65016-61003	1584 kWh
National Grid	Electricity	15 Einhorn Rd	8/18/09 - 9/17/09	133.55	10/14/2009	77476-77002	891 kWh
National Grid	Electricity	16 Einhorn Rd Apt 1	8/18/09 - 9/17/09	64.99	10/14/2009	15193-62014	411 kWh
National Grid	Electricity	17 Einhorn Rd Marilyn Myers	8/18/09 - 9/17/09	49.86	10/14/2009	89946-61002	305 kWh
National Grid	Electricity	17 Einhorn Rd Apt 3 Pole 6	8/18/09 - 9/17/09	6.3	10/14/2009	27661-07002	0 kWh
National Grid	Electricity	2 Elbridge St Apt 2	8/18/09 - 9/17/09	100.4	10/14/2009	77476-59004	659 kWh
National Grid	Electricity	8 Elbridge St Apt 1	8/18/09 - 9/17/09	91.26	10/14/2009	27629-10003	595 kWh
National Grid	Electricity	8 Elbridge St Apt 2 John Miller	8/18/09 - 9/17/09	96.42	10/14/2009	52550-60000	631 kWh
National Grid	Electricity	8 Elbridge St Apt 3	8/18/09 - 9/17/09	114.14	10/14/2009	40089-81006	755 kWh
National Grid	Electricity	10 Elbridge St Apt 1 Pole 5	8/18/09 - 9/17/09	33.59	10/14/2009	89946-42007	191 kWh
National Grid	Electricity	10 Elbridge St Apt 2 Pole 5 Dept of Plant Svcs	8/18/09 - 9/17/09	64.87	10/14/2009	02841-68001	410 kWh
National Grid	Electricity	10 Elbridge St Apt 3 Pole 5 dept of plant svcs	8/18/09 - 9/17/09	34.02	10/14/2009	15193-45004	194 kWh
National Grid	Electricity	16 Elbridge St (frat house)	8/18/09 - 9/17/09	368.75	10/14/2009	77476-58007	2292 kWh
National Grid	Electricity	20 Elbridge St BSMT	8/18/09 - 9/17/09	64.43	10/14/2009	65016-42008	407 kWh
National Grid	Electricity	20 Elbridge St Apt 1 dept of plant svcs	8/18/09 - 9/17/09	25.73	10/14/2009	40089-80009	136 kWh
National Grid	Electricity	20 Elbridge St Apt 3	8/18/09 - 9/17/09		10/14/2009	52550-59007	451 kWh
National Grid	Electricity	30 Elbridge St Apt 1	8/18/09 - 9/17/09	58.99	10/14/2009	52550-57003	369 kWh
National Grid	Electricity	30 Elbridge St Apt 2 plant svcs	8/18/09 - 9/17/09	85.98	10/14/2009	65016-41001	558 kWh
National Grid	Electricity	8 Hackfeld Rd Apt 1 Plant svcs	8/18/09 - 9/17/09	40.45	10/14/2009	52552-73016	239 kWh
National Grid	Electricity	8 Hackfeld Rd Apt 2	8/18/09 - 9/17/09	60.13	10/14/2009	65016-63007	377 kWh
National Grid	Electricity	8 Hackfeld Rd Apt 3	8/18/09 - 9/17/09	38.29	10/14/2009	77476-79006	224 kWh
National Grid	Electricity	10 Hackfeld Rd	8/18/09 - 9/17/09	72.29	10/14/2009	40090-41001	462 kWh
National Grid	Electricity	11 Hackfeld Rd Plant svcs	8/18/09 - 9/17/09	27.88	10/14/2009	27629-32036	151 kWh
National Grid	Electricity	12 Hackfeld Rd	8/18/09 - 9/15/09	53.28	10/14/2009	27629-30005	329 kWh

Appendix V: Presentation to Facilities

2/25/2010, Presented to Mike Lane and Marylou Horanzy

3/11/2010





Project Overview

Utilities Billing	Meter Locations	Meter Monitoring
• Obtained bills • Analyzed current records system • Investigated billing methods with utilities companies	• Physical meter locations • Discovered discrepancies • Developed web-based map	• Roy Cordy, Clark • Need for individual metering • Examined several software options

Meter Map

- Web-based map system
  - HTML / CSS
- Aid Facilities and utilities companies in locating physical meters on WPI-owned properties
  - Inventory / Tracking
  - Safety
- Possibly expand to include:
  - Water meters
  - Sprinkler systems
  - Fire alarms
  - Fire extinguishers

Meter Map Demonstration

WPI - Utilities Management - Map System

Clark University Utilities Management

Individual Building Metering	• Schneider Electric • Real-time tracking of campus-wide usage • Only visible to upper-management
Utilities Records and Trends	• Records from time of meter installation • Graphs of data available to analyze trends • National Grid's Schneider Electric monitoring system
Residence Hall Competitions	• Reduces costs since students use less energy • Improves sustainability profile of campus • Pizza party for the winners (largest decrease in consumption)
Co-Generation	• Diesel engine installed in 1982 • Exhaust boiler used to heat about four buildings • Saves about $30,000-$40,000 monthly

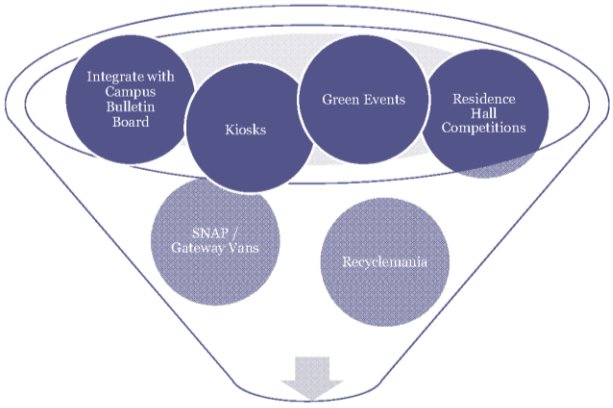
Lucid Design Group Overview

- Formed 6 years ago
- Approximately 100 customers
- Work with universities, businesses, and residences to increase sustainability awareness
- Modules:
  - Data downloader
  - Weather
  - Events (sync with Google calendar)
  - Renewable energy
  - Bus tracking at Harvard

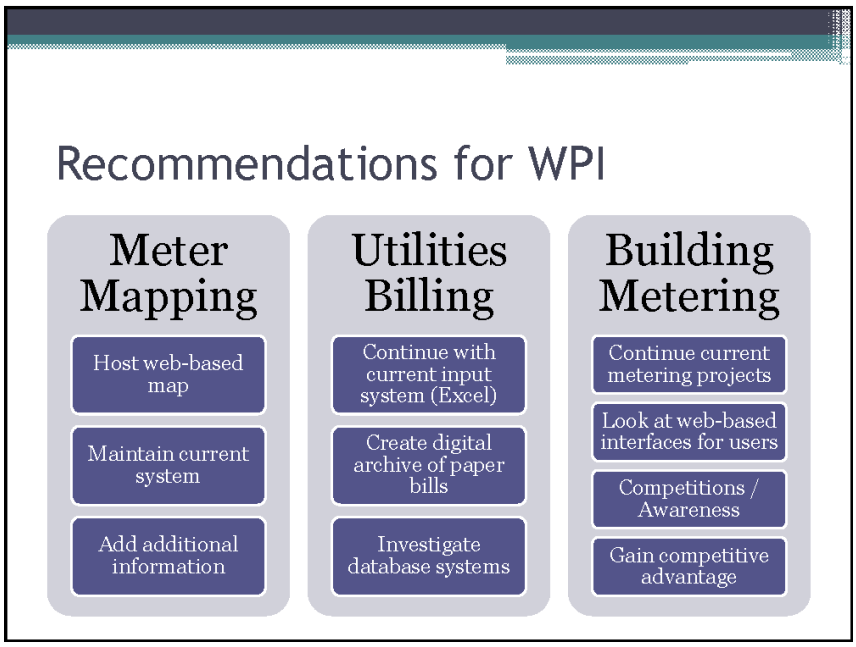
Hamilton College

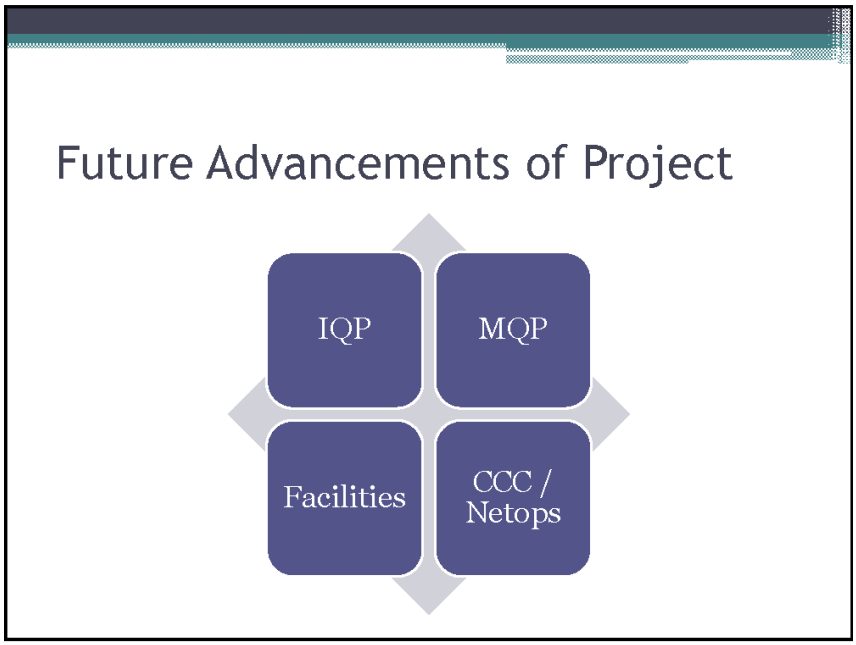
Harvard University

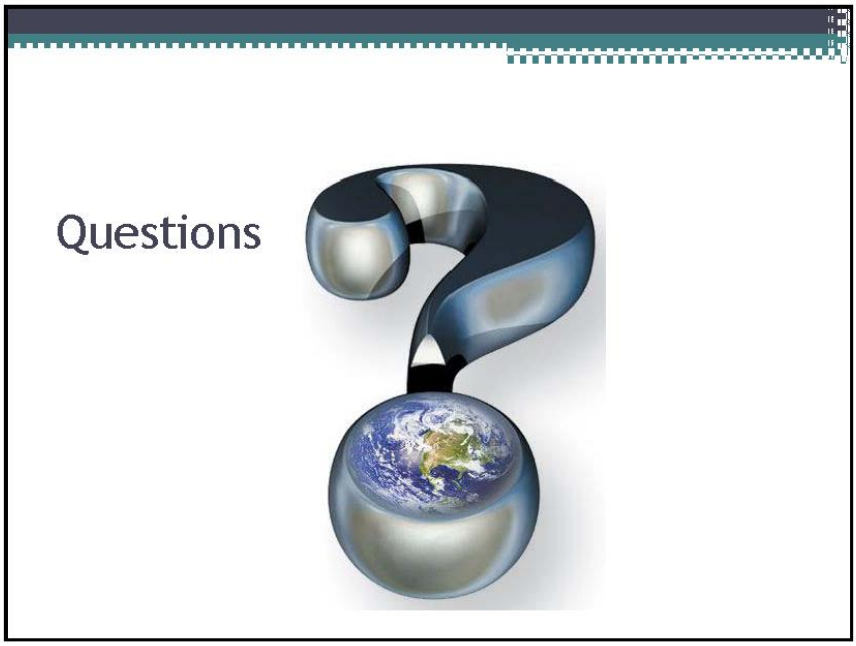
Possible Applications for WPI



Increased Sustainability and Campus Unity


Recommendations for WPI
Meter Mapping
Host web-based map
Maintain current system
Add additional information
Utilities Billing
Continue with current input system (Excel)
Create digital archive of paper bills
Investigate database systems
Building Metering
Continue current metering projects
Look at web-based interfaces for users
Competitions / Awareness
Gain competitive advantage


Future Advancements of Project
IQP
MQP
Facilities
CCC / Netops


Questions